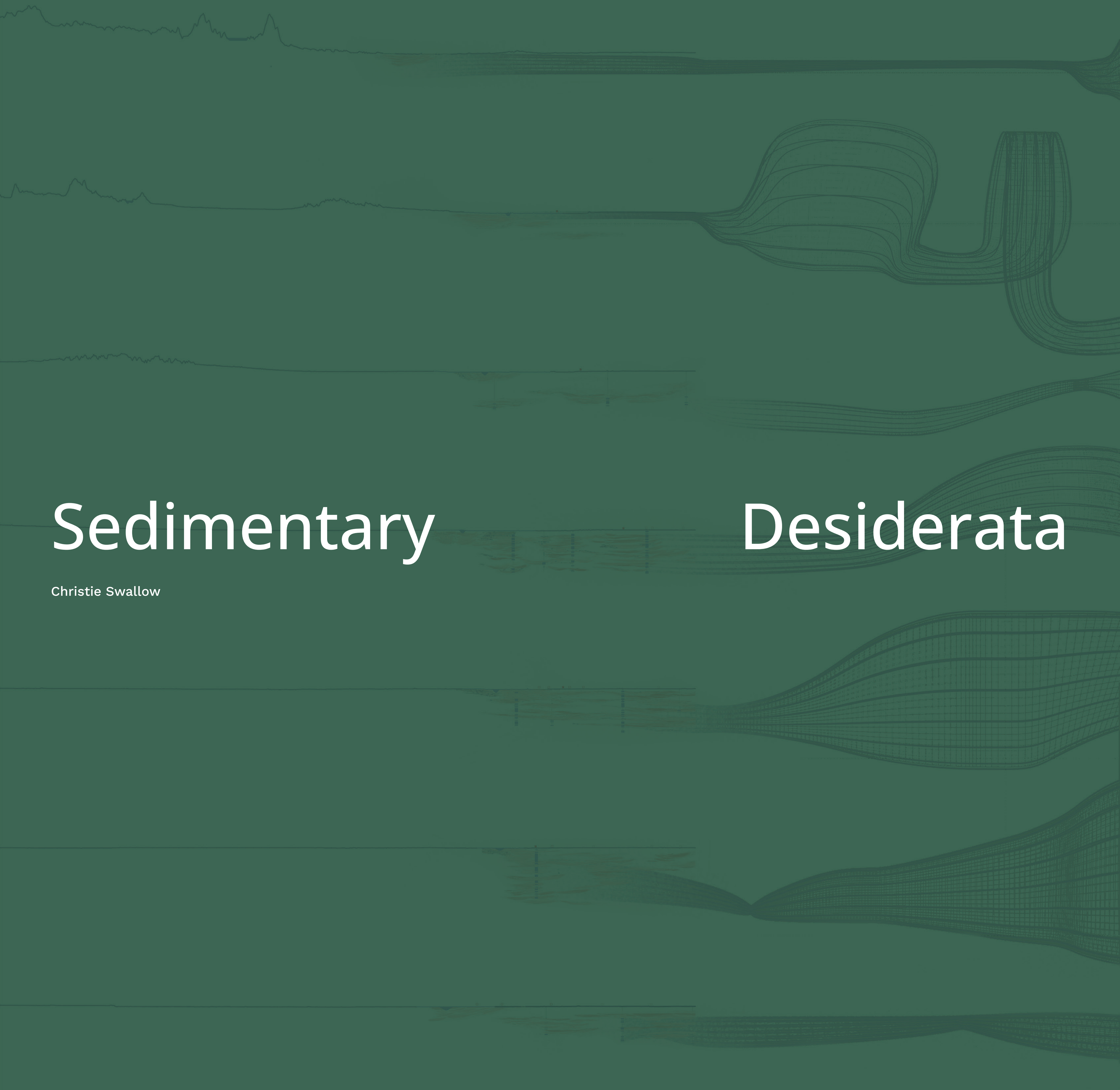

# Sedimentary Desiderata

Christie Swallow

~~Stratification of Desiderata~~

~~Module of the Known~~

~~Monument to the Unknowing~~

~~Missing Substrate~~

~~Sedimentary Desiderata~~

~~Command:Duty~~

~~Coefficient of equity~~

# Sedimentary

Formed by accumulation or deposition

# Desiderata

Things desired & wanted; currently lacking

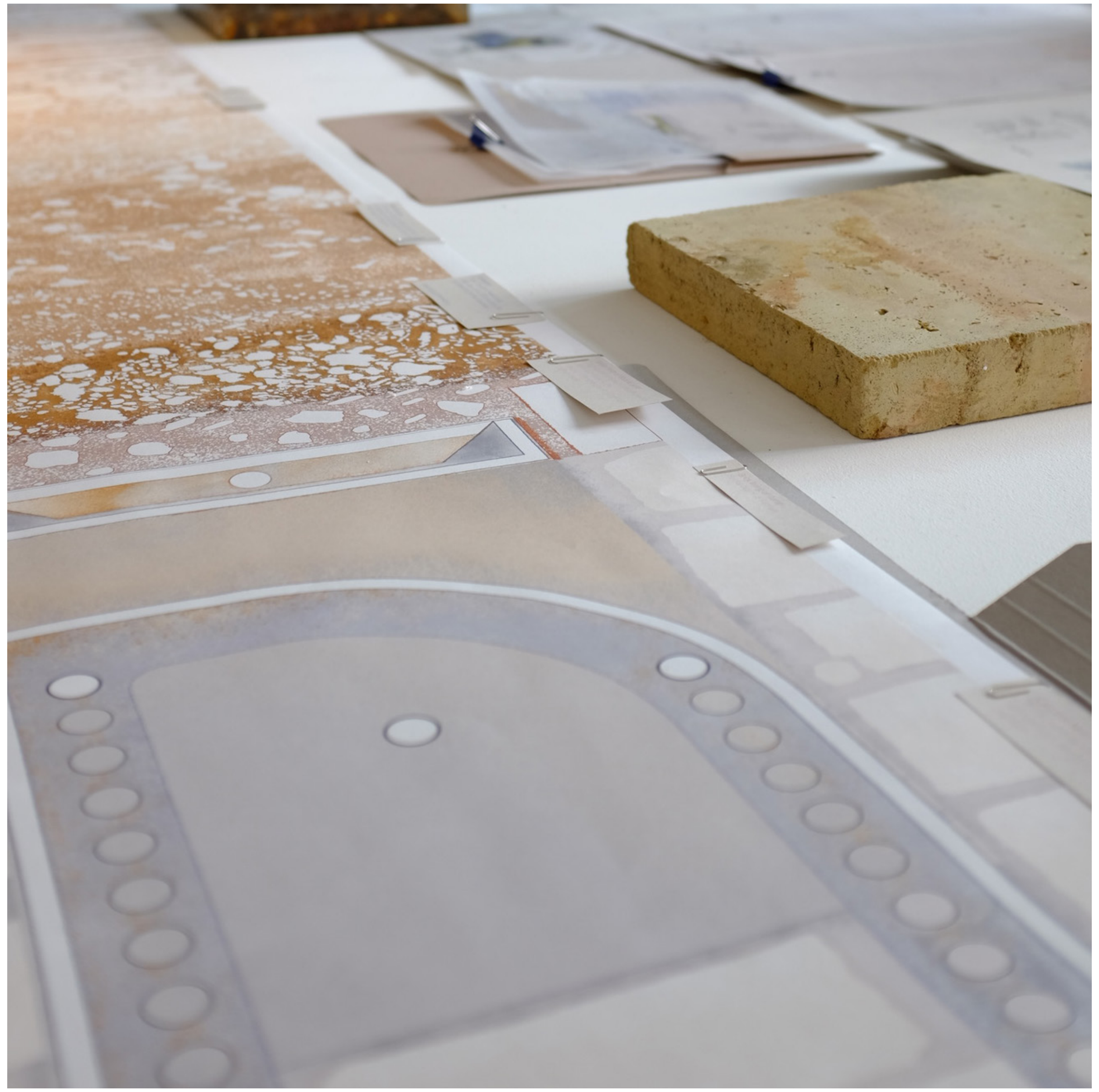

Image from MA1 EA Rs5 exhibition install showing 1:1 section
of outlet, material sample studies and archival folios

8 **Ø Introduction**
Engineering processes need to be understood as epochal in scale and impact → Moving between 'substrates' → Excavating the textual substrate of design logic to understand its impact on the geologic strata → How the archives, removed from the Punjab, continue to exert environmental harm

14 **① Canal:Channel**
Using the Adjustable Proportional Module (APM), a standardised infrastucture as an Interscalar Vehicle → Showing how a canal "system" produces arable space through the rationality/dispositions of its constituent parts → The function of the APM works in relation to other standardised elements, meaning it is nodal and not centrally controlled

38 **② Sediment:Specification**
The Punjab's contemporary soil/geology arose from ongoing processes
→ Alluvial fans produce both fertile soil and problematics for agriculture, which canal construction has sought to address
→ Understanding the gap between the geology as it exists
→ The soil as an archive

62 **③ Desiderata:Desedimentation**
The Outlet as it is standardised today arose from specific processes
→ These processes deposited political ideologies within the design of the APM → De-sedimenting this lineage can be achieved through the archival record → Tracing these biases can elucidate the ongoing impact that the canal system has on contemporary struggles

90 **④ Archiving:Recording**
The Archive is a site of struggle → The means by which the archive has reamined in the UK also allow it to be a site of intervention
→ Alternative means of archiving → Intervening in the Archive

126 ⑤ Conclusion

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Detail of model

**Acknowledgements**

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0

# Introduction

# Introduction

*The Indian Service of Engineers in which the British and their Indian Colleagues laboured for so many years has passed away, [but] The tradition remains and is a living force [...] The irrigation works of India and Pakistan, down to the smallest distributary channel and the loneliest canal inspection house must always remain a monument to the unknown engineer*
→ Lacey, 1947, via Gilmartin, 2021, 3

*The idealized architectures of social formations that have hitherto been thought of as purely "social" structures are now beginning to betray their subtended geologies. [...] This new vision of the geologic underpinnings of social formations suggests that the "standing stock" of matter was never a suitable means to theorize how the geo and social hook up, or come to matter, nor does it adequately account for the full reach of those geosocial formations into time and sub-surface matter. [...] what was once imagined and imaged as extraneous and external to the rational projects of materializing late modernity might now seem to have found it had a missing substratum.*
→ Yusoff, 2017

*In the body of this inscription, we must at least underline all the words which point, indeed, toward the institution and the tradition of the law ("lawmakers"), that is to say, toward that archontic dimension without which one could not have archives, but also, more directly, toward the logic and the semantics of the archive, of memory and of the memorial, of conservation and of inscription which put into reserve ("store"), accumulate, capitalize, stock a quasi-infinity of layers, of archival strata which are at once superimposed, overprinted, and enveloped in each other. To read, in this case, requires working at geological or archaeological excavations, on substrates*
→ Derrida, 1995, 20

Sedimentary Desiderata explores how the design, and desires, of scientific irrigation produced vast agricultural space within the Punjab. The project moves between the archival substrate - the documents and papers that produced engineering interventions - and the geologic substrate to argue that engineering processes need to be understood as epochal in scale and impact. The project asks how the textual substrate of the archive continues to be an active force. Through the environmental harm the archive produces, the Punjab's strata themselves become a counter-archive, testifying to the sedimentation of design desiderata.

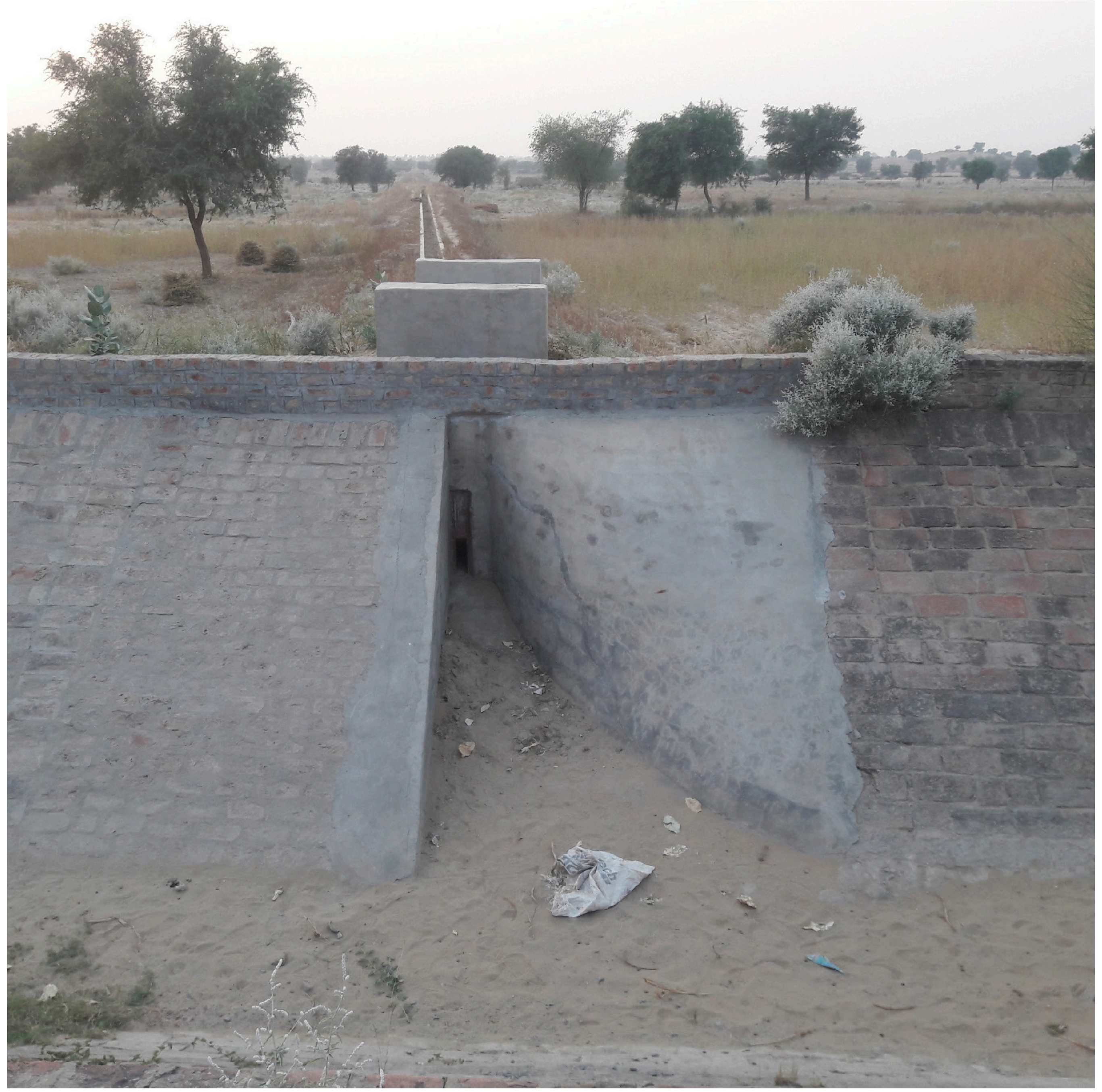
This is principally explored through the design of the outlet. Used to convey water from the vast Punjab canal networks to field, the outlet straddles legal, political and engineering rationale through its threshold status under the 1873 Canal Act, as the terminus of government control and the entrance into private cropland. The outlet was also a central design problem for Engineers over a century of irrigation design, leading to India Standardising the Crump Adjustable Proportional Outlet in 1976 (shown on the facing page), a design originally published in 1922. By recommending the Crump Adjustable Proportional Outlet, its particular, historical dispositions have been sublimated by the rhetoric of 'best practice' and being a neutral piece of infrastructure. I use the outlet as an interscalar vehicle [Hecht, 2018] to explore this process and how through the outlet the ideology of the Canal Colonies under the British Raj continues to have an impact today.

The 1922 design continues to embody its historical desires, and with this it affirms a historically-specific operational/abstracted readings of the subsurface - seeing the subsurface as a resource to be capitalised on. Through a sectional aesthetics [Yusoff 2017], engaging with the alluvial composition of the Punjab, Sedimentary Desiderata engages with the archival documentation and the comparitive invisibility of the subsurface to elucidate how the outlet's continued accordance with the desiderata of Raj engineers works in discordance with contemporary agricultural policy.

Situating the outlet as it is standardised today against the engineering rationalities that subtend it is enabled through my privileged access to archival materials; in the India Office Records, controversially held in London, and the Punjab Engineer's Congress archives in Pakistan.

From 2022 to 2023 Environmental Architecture Research Studio 5 researched, questioned and engaged with water practices, looking principally at the Indian Punjab. My first Engagement with the Punjab came through the archive. Environmental Architecture Studio 5 entered the site through a 1906 map of the Punjab Triple Canal System [Benton, 1906], a masterplan for an interconnected canal network. I initially took this map as a faithful (re) presentation of the canal colonies as they exist. However, I began to see how the map precedes but also impacts the territory; reading the engineering ambitions of canal colonies against revenue reports, irrigation branch papers, or legal instruments, I saw how the textual record and its archive could be understood as a "site" of environmental architecture.

This exploration was further explored through the studio's engagement with the ongoing struggle experience within Zira, Firozpur, Punjab. In researching the still-ongoing struggle for clean groundwater against pollution from local ethanol industry, I began to see representation itself - the maps, documents, records I was engaging with - as subtending the strata being subject to pollution. Resistance to the polluting practices of local industry were fought and strained through subversion of this documentation; of Environmental Reports, Statements of approval written in letters issued to officials, and rubber stamp studies of contaminant concentrations, coalescing to produce a map pointing away from on-the-ground testimony.



In Situ photo of Adjustable Proportional Modules in an empty parent channel. Images by Nahri Gyan, 2020

# Missing Substrates

The need to see the archival through the geologic and vice versa

*From the beginning of colonial rule, in Punjab and elsewhere, colonial officials had been driven by the desire to "improve" landscapes and modernise agrarian spaces, even as they sought to maximise revenue returns. But they had found it impossible to put their visions into practice and transform images into reality. Operating in areas with their own histories and traditions, faced with deeply entrenched social structures, and confronted with a maze of customs, practices, and ecological variations, the British had repeatedly to back- track, rework their conceptions, and modify their vision. They had to arrive at policies that were feasible and viable within the given contexts. The imagined ideal was persistently disturbed by the politics of the possible.*

→ Bhattacharya, 2012, 1

*Changes in structures for controlling water transformed the Indus basin in the century and a half from 1850 to 2000. A largely arid region with a historical mix of varying forms of agricultural and pastoral production, the Indus basin became, by the second half of the twentieth century, one of the globes most heavily irrigated river basins. At the time of the British departure in 1947, there were some twenty-six million acres of irrigated land within the Indus basin, which encompassed by then the largest integrated, state-controlled irrigation system in the world- and one that had made the region one of the most agriculturally productive in India.' Divided between India and Pakistan by the subcontinent's partition, the Indus basin's irrigation expansion nevertheless continued apace after 1947-on both sides of the border. The Indus basin today supports a dense agricultural population whose size would be unthinkable without the transformations that extensive irrigation wrought.*

→ Gilmartin, 2021, 1

Sedimentary Desiderata contributes to the ongoing critique of post-colonial infrastructure and knowledge practices. In this exploration I have stayed-with the canal outlet - specifically the Adjustable Proportional Outlet (model shown on page 9) - a physically small element but pivotal in its operation. By approaching the canal infrastructure through this seemingly innocuous design I have seen how there is a scalar bias in understanding the infrastructure of the Punjab.

Key historical studies covering the Punjab Canal Systems have been written with regard to differing focusses ie role of modernity and bourgeous rationality [Bhattacharya, 2012], the bureaucratic management of space and its consequences [Ali, 1988] and the role of custom versus law [Gilmartin, 2021]. Common to many accounts is a tendency to privelage the macro- scale and with it an assumed master-plan vision. The specific dynamics of engineers operating within the Public Works Department has largely been overlooked. This is particularly prescient today; during the COP27 talks in 2022, Pakistan's delegation let calls for wealthier nations to contribute funding towards climate change resilience and damage caused by global heating. This call was framed by both Pakistan and supporters as one of acknowledging the role that colonial infrastructural design (and post colonial multinational consultancy groups) have had in producing a landscape vulnerable to climate change induced damage.

Understanding the Punjab Canal Systems requires a sedimentary reading, where there is no founding act but instead an accrual of technological, societal and political ideas shaping their production. Critically engaging with this material is therefore to resist grand narratives in favour of granularity. I use de-sedimenting to mean sifting through what is uncritically taken as an advantageous progression of 'improvements' on the landscape. David Chandler [2014, 65] defines Desedimentation as "a concept-metaphor here as otherwise than a procedure that might be primarily one of recovery or return. I think of it as a kind of resetting, a setting afoot or apace, a destabilization".

Sedimentation of engineering rationality and desiderata unto the Punjab's alluvial strata has been excacerbated by a lack of access to archival material. As Caroline Elkins argues, "Archives are loaded sites that produce realities as much as they document them" [Elkins, 2015, 853]. As this project moves between the digitised India Office Records Archive and the Punjab Engineers Congress Archive, a more complex relation of state, individual and communal aspirations emerges. This structure has been largely overlooked by historians but points to how the ideology of the Raj was translated into still-existing infrastructural systems.

My archival investigations have been drawn primarily from the India Office Records (Held in the British Library) and the Pakistan Engineering Congress archive (Previously known as the Punjab Engineering Congress. Archive held in Lahore, digitised and published online). Entering this project through these archives has also required me to reflect on how I look at architecture and design with a scalar bias, privileging the large scale, the masterplan as being the principle authority. Through the archival, the vast scalar difference between an individual outlet and the vast canal colony becomes flattened. Plotted on comparable paper sheets or PDF scans, the outlet's operation can be equitably compared to the whole canal. I have explored the scalar through Hecht's [2018] concept of the Interscalar Vehicle, developed in part ①.

If the textual record can be manipulative of history and actively intervening on the landscape, then the question of who possesses and who has access to that record is central. The textual record should be understood as a substrate, in that information subtends the contemporary infrastructural landscape [Derrida, 1995]. Part ④ will outline the ongoing issues surrounding archival access and the power of the archival substrate. This chapter will also show how the British Library, as disputed owner / host of the archive, can also be a site for intervention.

Working through the archive and tracing the way desire and ideology became cemented into the present agricultural system is a necessary contribution to the field of environmental architecture as it serves to 'de-sediment' the contemporary infrastructural landscape. Such a critique must work from an understanding of how the canals and their infrastructure were originally designed. Within the Punjab, the engineers responsible for developing and imagining canal systems operated within and beyond the formal hierarchies of the Public Works Department (responsible for irrigation during the Raj). The Punjab Engineer's Congress, a private organisation founded in 1913, served as a fulcrum for the dissemination of ideas and thus in the cultivation of a distinct "design school". Members of the congress and the Public Works Department would circulate desiderata [Varma, 1917], a term used to encompass their criterion and desired design of infrastructure. Such partial lists, laden with contemporary bias, have become uncritically sedimented in today's standardized infrastructural designs [Ersten, 2007]. To critique the contemporary landscape therefore requires a de-sedimentation of this desiderata. This is discussed in Part ③.

Through the canal outlet and its textual referrents I will show that the production of the "legible" vision does not simply descend from an authoritarian masterplan, but instead discrete documents bound and held in the archive representing vast differences in scale worked relationally, and through this the canal systems. This upended my initial assumption that the order of the canal system descends from a singular, 'god's point of view' masterplan vision, and highlights the way canal infrastructure and the problems it has produced have been mis-understood. This is explored further in Part ①.

There have limited studies in the role of colonial irrigation both within and without the Punjab. Gerardo Van Halsema's 2002 Thesis "TRIAL & RE-TRIAL The Evolution of Irrigation Modernisation in NWFP, Pakistan" chronicles the progression of outlet design to the Crump Adjustable Proportional Module and Pakistan's post-partition reckoning with its suitability. However van Halsema's approach privileges quantitative measurements and comparisons of outlets as a means of gauging how and why they were deployed in the Punjab. Sedimentary Desiderata contextualises the 'official' archival record against the hitherto overlooked record of the Punjab Engineer's Congress, showing the substrata of desiderata - desire and ideology - and their role in the outlet's design and deployment.

The emphasis on ideology over engineering rationale in the formation of Punjabi agricultural production has been highlighted by Kapil Subramanian [2015] who argues that many studies privilege large scale 'emblems' of engineering; huge nationalist-infused dam- building, etc. However Sedimentary Desiderata is not a plea for engineer's to better obey rationality in their design. Rather, I will show that just as the outlet is historically contingent, so too is the 'rationality' used in design, following Picon's conception of the interplay between rationality and imagination [Picon, 2004].

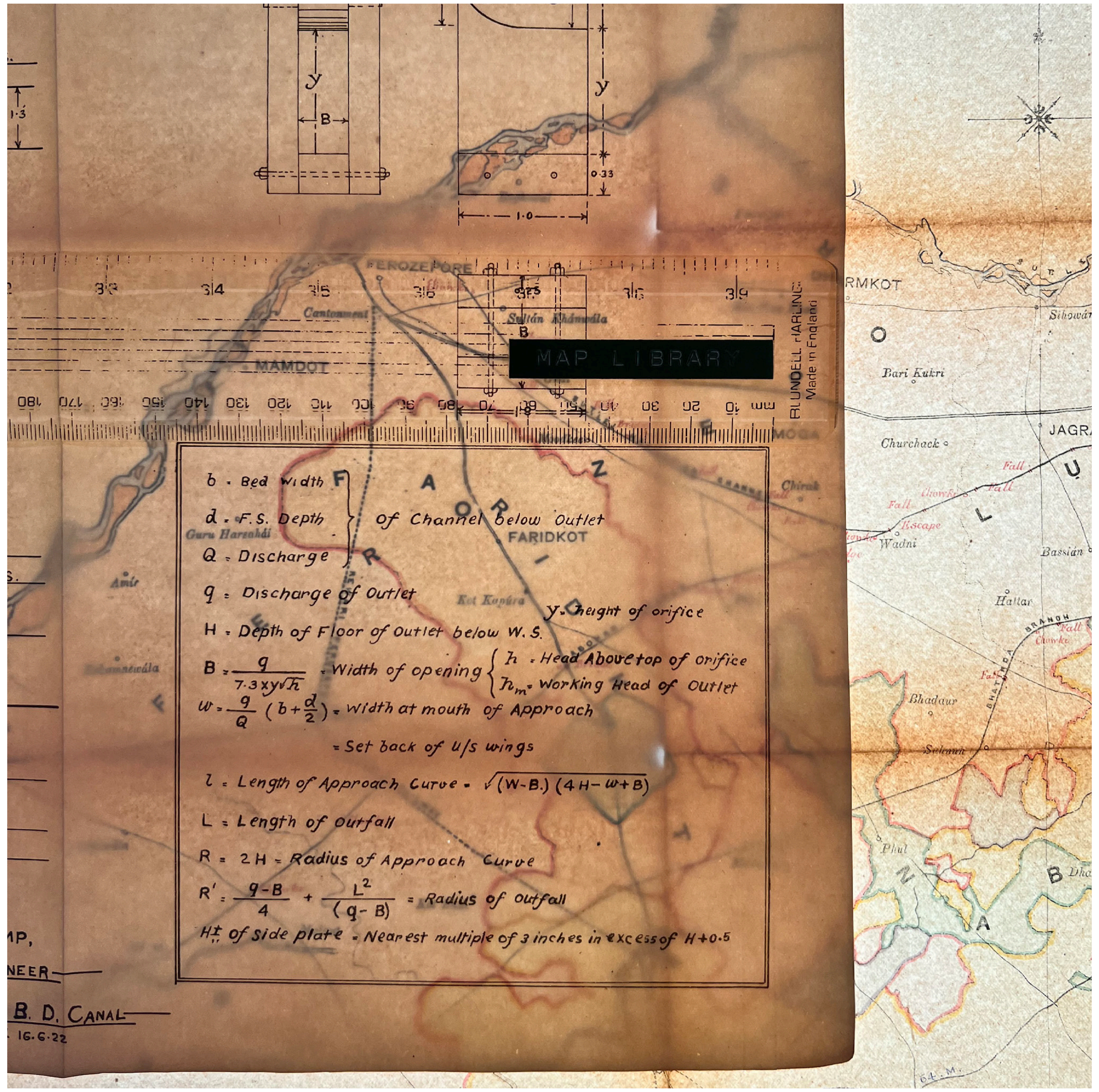
The emergent system produced by the outlet(s) enforces my central methodology of drawing-as-intervention. I have wrestled with how representation of ideas and understanding proceed to act on the world; the canal outlet exists as 1000's of cast iron structures due to its standardised drawings being disseminated. Likewise, the understandings and models used to abstract the complex geological reality into a utilitarian model of that reality should be understood as operative; occluding certain details while emphasising others. Part ② outlines the ongoing issues of geological aesethics in the Punjab and the epistomological gaps that continue to cause problems.

The design of infrastructure is never a faithful question in seeking to rationally optimise the issue at hand, as that rational ideal is shaped, and shifted, by the context in which the designer operates. Ersten argues that:
*"The idea that artefacts have a design history, and thus cannot be regarded as neutral objects, does not imply that artefacts from one context cannot be applied in another. [...]there is indeed a relation between politics and design; next to artefacts and systems useful for the fulfilment of needs, engineers (designers) bring along a new societal reality."* [Ersten, 2015]

This thesis charts the morphologies of the textual substrate, how it abstracted the geologic, and how in turn the real substrata of the Punjab continues to bare witness to this process. By staying with the geologic, the archival strata can be de-sedimented.

①

Canal : Channel


MAP LIBRARY
FEROZEPORE
NAMDOT
FARIDKOT
RMKOT
JAGRA
Bari Kutri
b . Bed width
d . F.S. Depth of Channel below Outlet
Q . Discharge
q . Discharge of Outlet
y . height of orifice
H . Depth of Floor of Outlet below W.S.
B = q / 7.3xy√h . Width of opening
h . Head above top of orifice
h_m . Working Head of Outlet
W = q/Q (b + d/2) . Width at mouth of Approach
= Set back of u/s wings
l . Length of Approach Curve = √(W-B)(4H-W+B)
L . Length of outfall
R = 2H . Radius of Approach Curve
R' = (q-B)/4 + L²/(q-B) . Radius of outfall
Ht of Side plate . Nearest multiple of 3 inches in excess of H+0.5
B. D. CANAL
16-6-22

Archival material within the British Library overlaid over a lightbox

# Introduction

*The scope of [irrigation] systems is delimited by the reductionist character of the applied knowledge, which is based on reducing the natural surroundings to empirical, refutable and predictable relations. To be designable, or engineerable, a problem, and the system to cope with that problem, needs to be structural: "[...] the engineer's problem is a structural one: there is a gap to be bridged between the desired future state and the present state; how to bridge it is the problem"*
→ Gerardo Enrique van Halsema, 2002

*During their study, the Authors came across the names of a very large number of officers who had something useful to say on the subject, but the biggest contribution comes from two officers of the Punjab Irrigation, Messrs Kennedy and Crump - All honour to them. [...] The most important landmark in the history of development of irrigation outlets was the publication in 1922 of Punjab .I B. Paper No. 26 on the moduling of irrigation channels by Mr. E. S. Crump.*
→ Mahbub & Gulhati, 1944, 2,24

*The information collected on the subject indicates that pipe outlet, both of non-modular type and semi-modular type, depending upon method of installation and open flume outlets and Crump's adjustable proportional module of semi-mpdular type has generally been adopted in the country.*
→ IS:7986, 1976, 3

The Adjustable Proportional Module (APM) core element, a cast iron casing approximately 300mm x 300mm x 600mm, applies a distinct rationality across the entire canal system. Using Hecht's concept of an Interscalar Vehicle and applying this to the APM, I will show that the production of the canal colonies, both historically and presently, is performed through the nodal relationship of standardised designs; that the rationality of the system emerges through the outlets ubiquity.

The design of the APM is standardised as India Standard 7986, 1976. It's widespread deployment reflects its meeting of a particular set of needs for outlets which have become expected (see Part 3 for more details)

Its standardisation and widespread useover the last century has meant the outlet's design dispositions [Easterling, 2016] are able to transform and re-order the distribution of water across large scale canal networks. This means that the outlet challenges classical understandings of infrastructure as being exclusively derived from a top down, master plan vision and allows retroactive changes to existing canal systems.

Gabriel Hecht's Interscalar Vehicles [2018] concept helps to outline how the outlet operates in an emergent fashion Hecht uses Interscalar Vehicle to refer to "objects and modes of analysis that permit scholars and their subjects to move simultaneously through deep time and human time, through geological space and political space" [ibid, Abstract].

**Keywords**

→ Chak
An area (typically village settlement) served by one outlet. from Chakar, Punjabi term for water well

→ Command
Crop area that can be irrigated from an outlet

→ Duty
Irrigation Capacity of a unit of water. Derived from James Watt's Steam Engine and metrics for comparative efficiency [Wescoat Jr, 2013, 4762]

→ Flexibility
The ability for an outlet to draw water proportionally to the canal's supply

→ Interscalar Vehicle
A object of study whose affects and characteristics allow analysis to move from the particular object to other scales of space, temporality, and impact [Hecht, 2018]

→ Inundation Canal
A canal which draws water directly from the river. Water supply relative to river flooding.

→ Perennial Canal
Canal which supplies water throughout the year

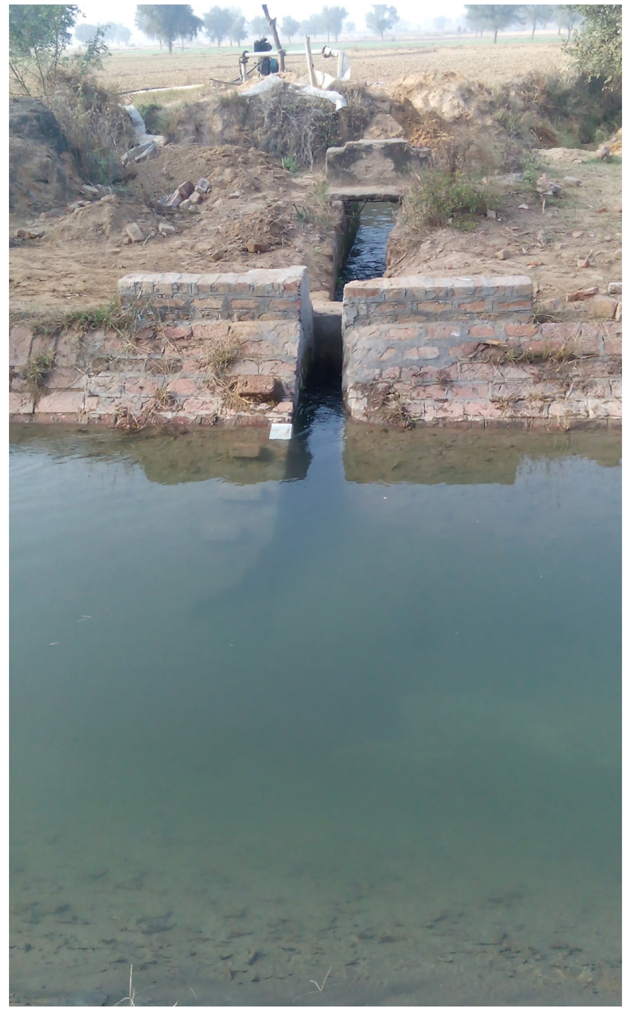
Canal:Channel

## Irrigation:Infiltration

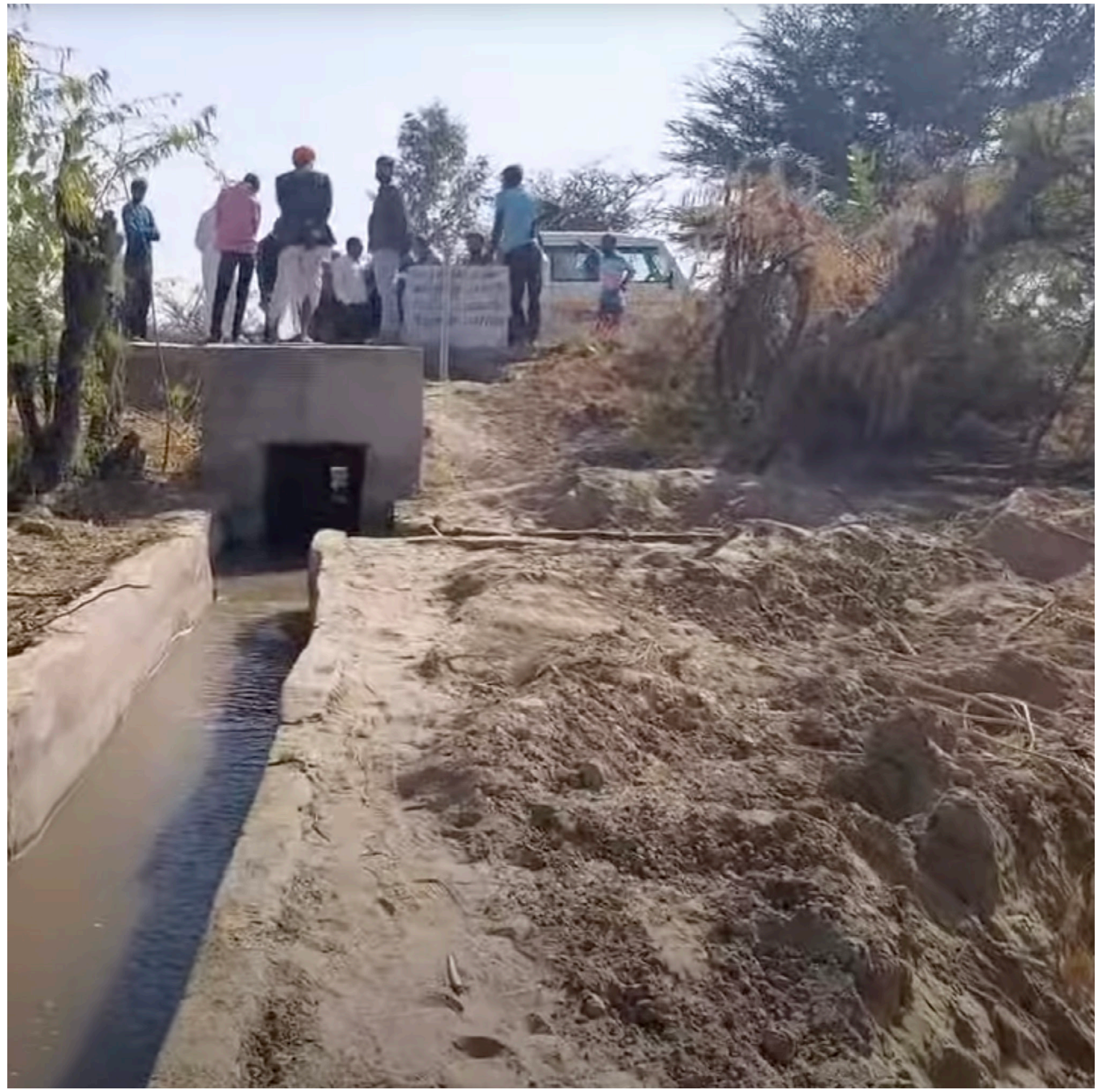
The need for an outlet that apportions water

Crops require water and oxygen to mature, which are osmosised via the plants roots within the A soil horizon. A crop's requisite water must be supplied regularly so as to avoid waterlogging - where soil is over saturated with water, starving the roots of oxygen.

This means predicable and frequent water supply is necessary. Perennial Canals are designed to provide water all year round to meet this need.



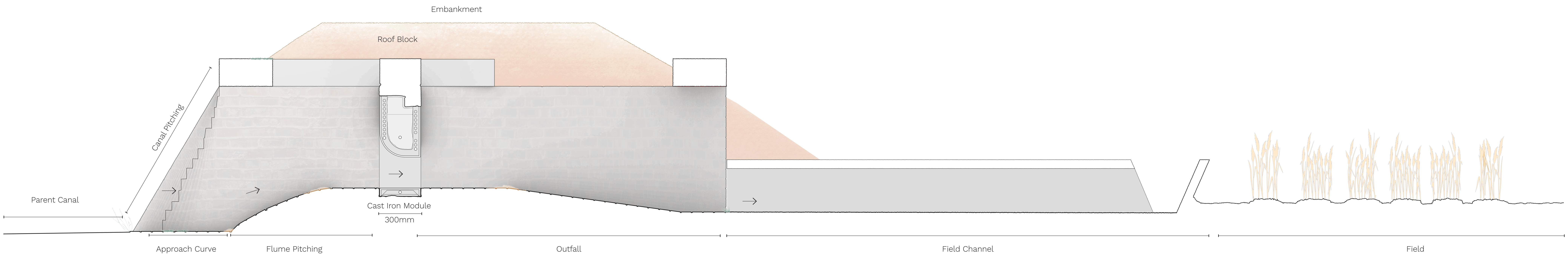
A perennial canal conveys water from rivers and reservoirs to fields, via the outlet. The design of the outlet is therefore crucial as a determinant of how water is distributed from canal to different field channels.



Left: Sixtybolts, 2008
Centre and overleaf: Stills from Tokri, 2021
Right: Gyan, 2020

Canal:Channel

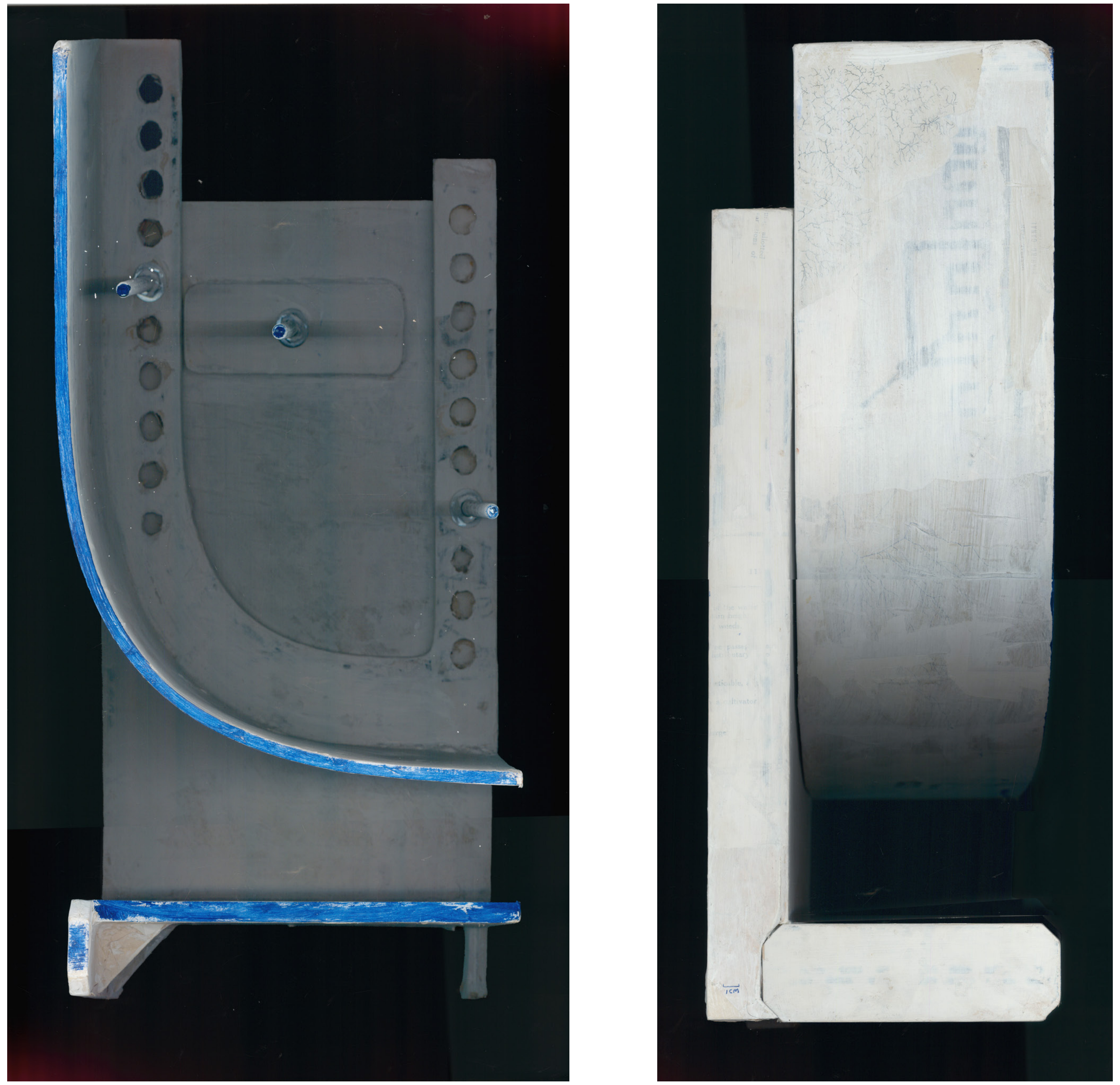
# Irrigation:Cultivation


Embankment
Roof Block
Canal Pitching
Parent Canal
Cast Iron Module
300mm
Approach Curve
Flume Pitching
Outfall
Field Channel
Field

Section through An Adjustable Proportional Outlet (APM). The APM provides water for multiple fields bounded by field channels, known as a Chak. This allows multiple small-plot farmers to access the canal water.

The APM's flume works in conjunction with its cast iron cast iron module to control the outflow of water relative to the Duty the outlet commands, while ensuring that proportionate levels of silt are taken in [Sharma, 1934].

The duty volume is set by adjusting the height of the Cast Iron Module, which is then set to that position by encasing it in concrete [Crump, 1922].

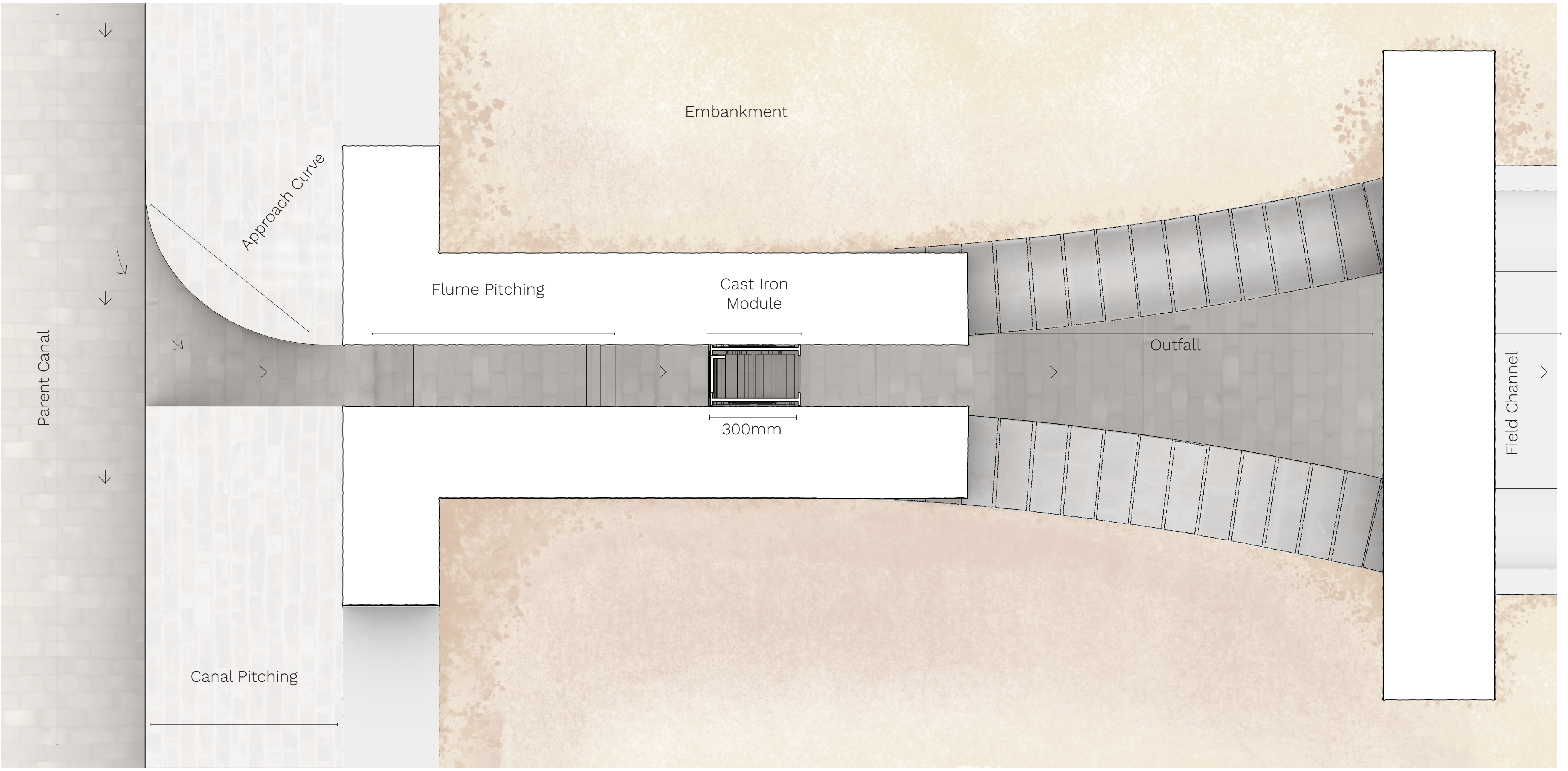


Scan of a model of Adjustable Proportional Module Cast Iron Insert

In Situ photo of Adjustable Proportional Modules in a full parent channel. Images by Nahri Gyan, 2020

Canal:Channel

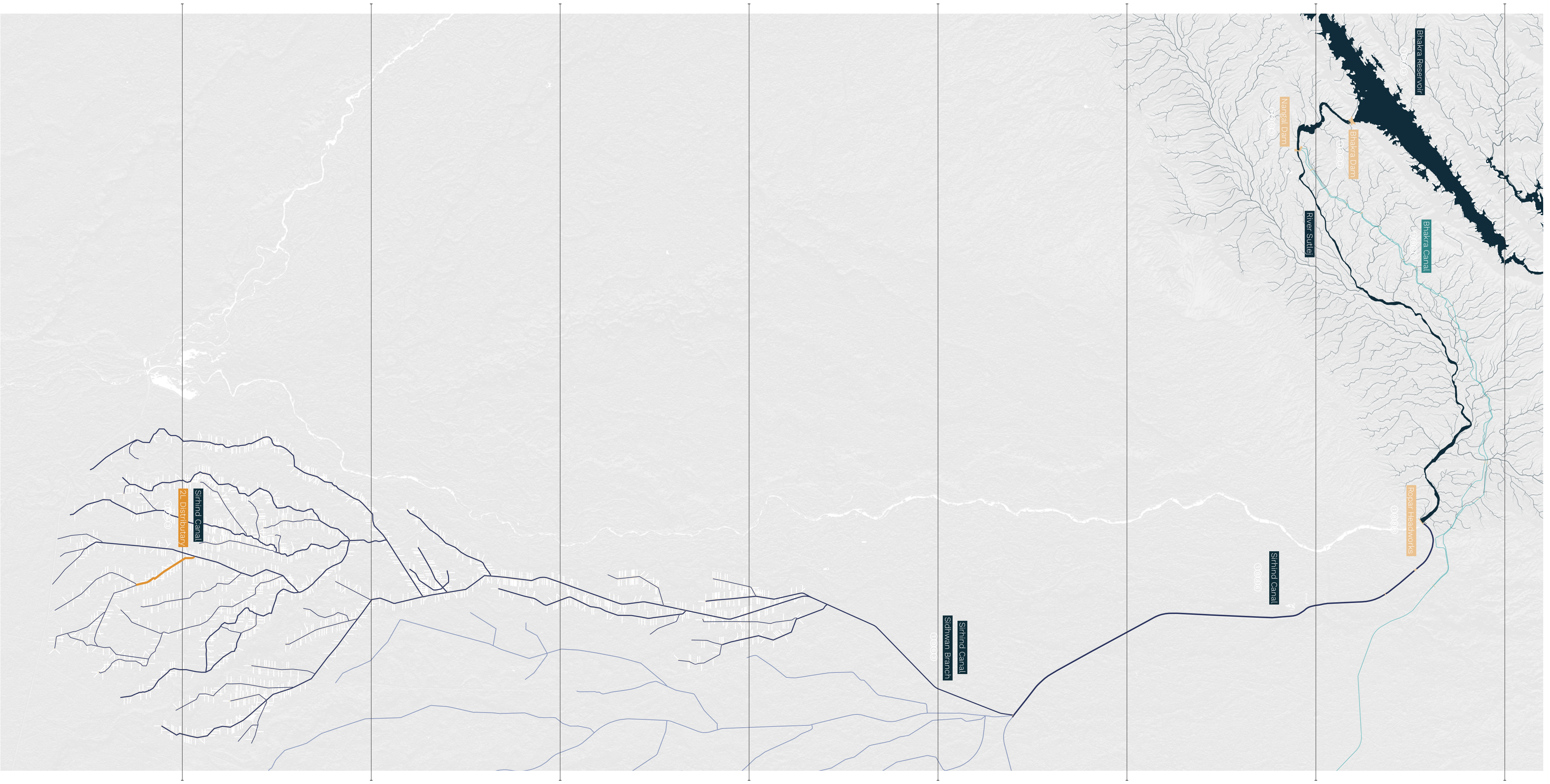
# Instance:Network


Embankment
Approach Curve
Flume Pitching
Cast Iron Module
Outfall
Parent Canal
300mm
Field Channel
Canal Pitching

Plan of Standardised APM layout.
The outlet will draw more or less water relative to the available water within the canal and proportionate to the Chak area it commands. This is so that all outlets will recieve water regardless of their location upstream / downstream [Sharma, 1934].

An individual APM therefore functions to distribute water not just from canal to field channel but also to regulate the supply between it and the other outlets in a given canal stretch. This allows the Adjustable Proportional Module to operate isomorphically, scaling up a rationing process of water across a whole system.

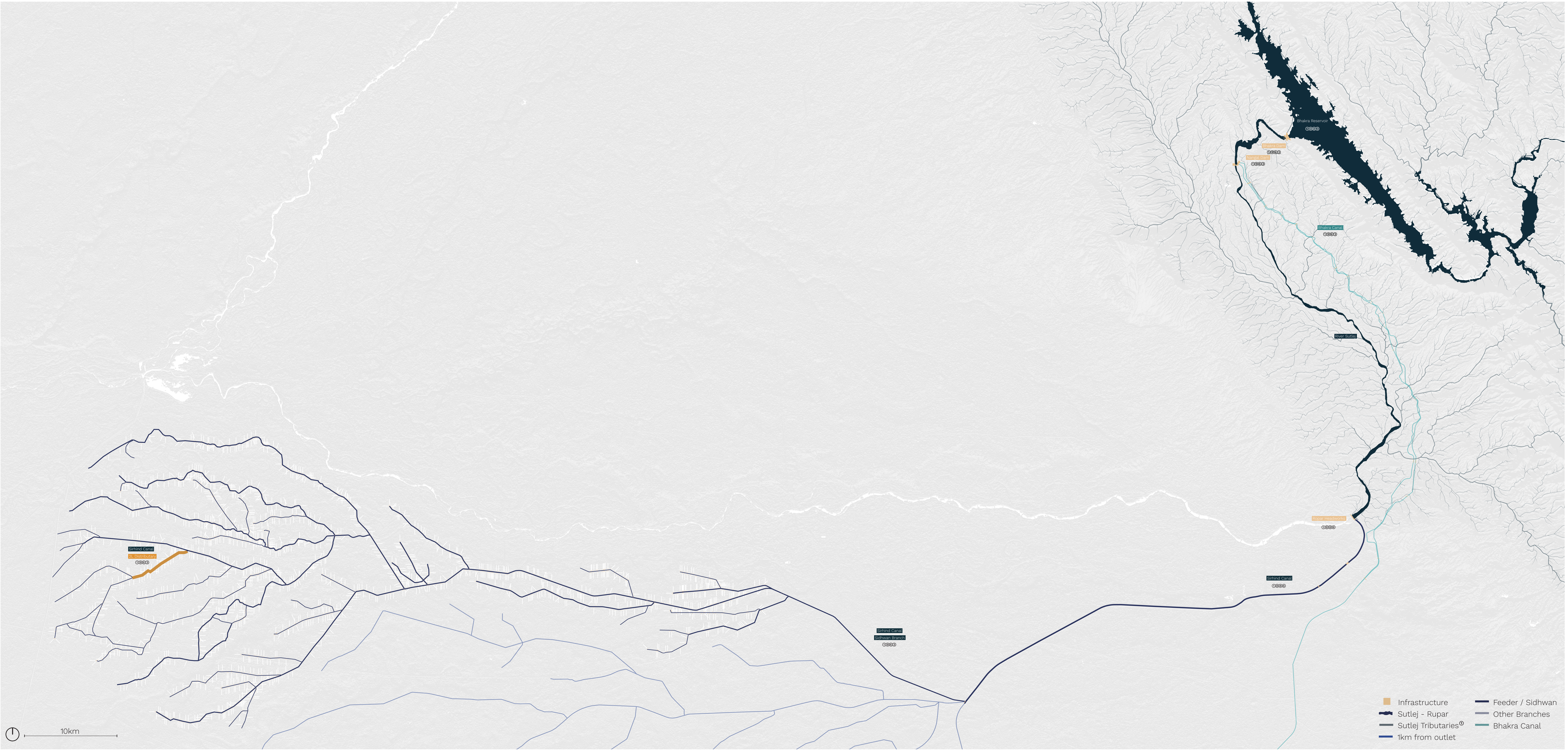
Along the Sidhwan Branch (Right) ~1800 outlets produces an emergent network of water distribution across 1,710 square kilometers of culturable land.



**Map of the Sirhind Canal, Sidhwan Branch**

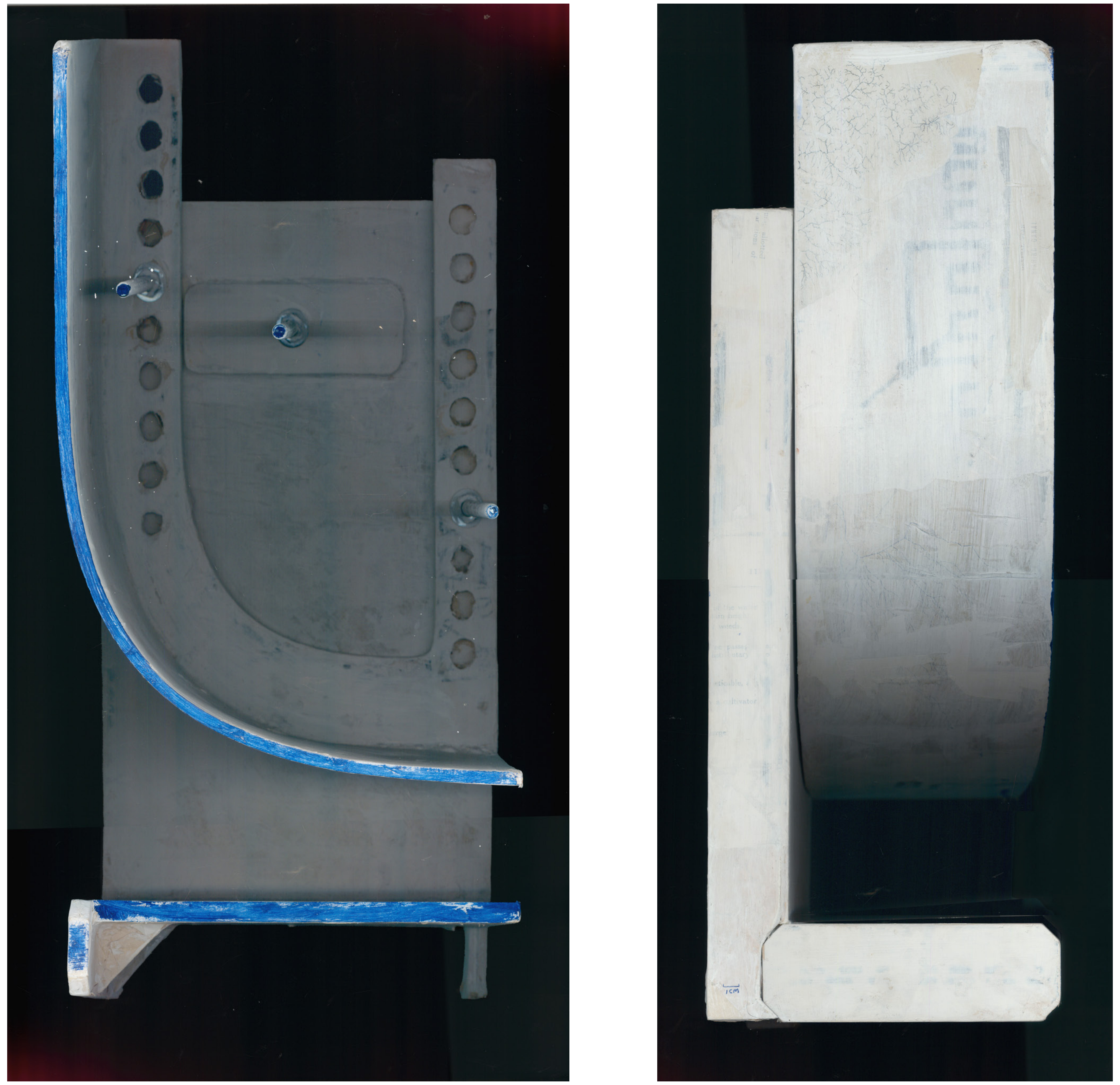
10km
Section Lines
Sutlej - Rupar
Sutlej Tributaries①
1km from outlet
Feeder / Sidhwan
Other Branches
Bhakra Canal
Infrastructure

① Hydrobase River Digitisation. Topography derived from Landsat DEM. All other features manually digitised with reference to satellite imagery


Bhakra Reservoir
①⑨⑥③
Bhakra Dam
①⑨⑥③
Nangal Dam
①⑨⑥③
Bhakra Canal
①⑨⑥③
River Sutlej
Ropar Headworks
①⑧⑧⑥
Sirhind Canal
①⑧⑧⑥
Sirhind Canal
Sidhwan Branch
①⑨⑥③
Sirhind Canal
2L Distributary
①⑨⑥③
10km
Infrastructure
Sutlej - Rupar
Sutlej Tributaries①
1km from outlet
Feeder / Sidhwan
Other Branches
Bhakra Canal

In Situ photo of Adjustable Proportional Modules in
an empty / full parent channel. Nahri Gyan, 2020

Still from Ropar Headworks, by Maan Punjabi Blogger, 2021.



Model Scans, Left: Outlet, 1:1 Scale.
Right: Model of Sutlej river and
Sirhind Canal, scale 1:1,500,000

## Outlets make a plan

Canal systems emerge from the software of the outlet

*Indeed, as recent anthropological writing about scale deftly demonstrates, scale is not just about size or granularity. It is also about categories: what they reveal or hide, the ways in which they do (or do not) nest. And it is about orientation: how we position ourselves, what we position ourselves against, and what comparisons such locations do (or do not) authorize*
→ Hecht, 2018

*Infrastructure space, [...] behaves like spatial software. And while we also do not typically think of static objects and volumes in urban space as having agency, infrastructure space is doing something. Like an operating system, the medium of infrastructure space makes certain things possible and other things impossible. It is not the declared content but rather the content manager dictating the rules of the game in the urban milieu. [...] Infrastructure space is a form, but not like a building is a form; it is an updating platform unfolding in time to handle new circumstances, encoding the relationships between buildings, or dictating logistics. There are object forms like buildings and active forms like bits of code in the software that organizes building. Information resides in the, often undeclared, activities of this software—the protocols, routines, schedules, and choices it manifests in space. McLuhan's meme, transposed to infrastructure space, might be: the action is the form.*
→ Easterling, 2016

The relationship between the parts and the whole, the particular instances and the general, is an acute problem in understanding infrastructural space.

Before engaging with Environmental Architecture, my reflex was to find the map. The plan. the thing that pins it all down. But from my initial engagement with the Canal systems through masterplan mappings, I have been confronted with the contradictory nature of reprentation and operational imagery. Privelaging of the vast scale is excacerbated by digital mapping, affording me an infinite zoom into and out of the site, foregoing any rigid "scales" to rest on.

Architectural rationality continues to rest on a scalar bias. Le Corbusier famously wrote that "The Plan is the Generator" [Le Corbusier, 2008, 45]. Engaging through the archive attuned me to engage with vastly different scales of space and complexity juxtaposed next to one another, creased and dog-eared, on the table.

The outlet nonetheless boasts of large numerical value in its quantity; 1000's across India and Pakistan, operating independently but concordantly in their rationale. Here, it is useful to think of the outlet through Keller Easterling's Concept of Disposition.

Keller Easterling defines disposition as the latent potential that a thing has due to its design; *Disposition locates activity, not in movement, but in relationship or relative position [...] objects, static as they may be, posess agency. Disposition is immanent, not in the moving parts, but in the relationships between the components.* [Easterling, 2016]

Thinking of the outlet as possessing disposition allows for an understanding of its extrapolative function. If each instance of the standardized APM design works responsively with other APM's, an irrigation system emerges isomorphically.

Scalar logic is key to understanding the construction of space; from a masterplan scaling up or with the APM an infrastructural disposition producing an emergent rationality.

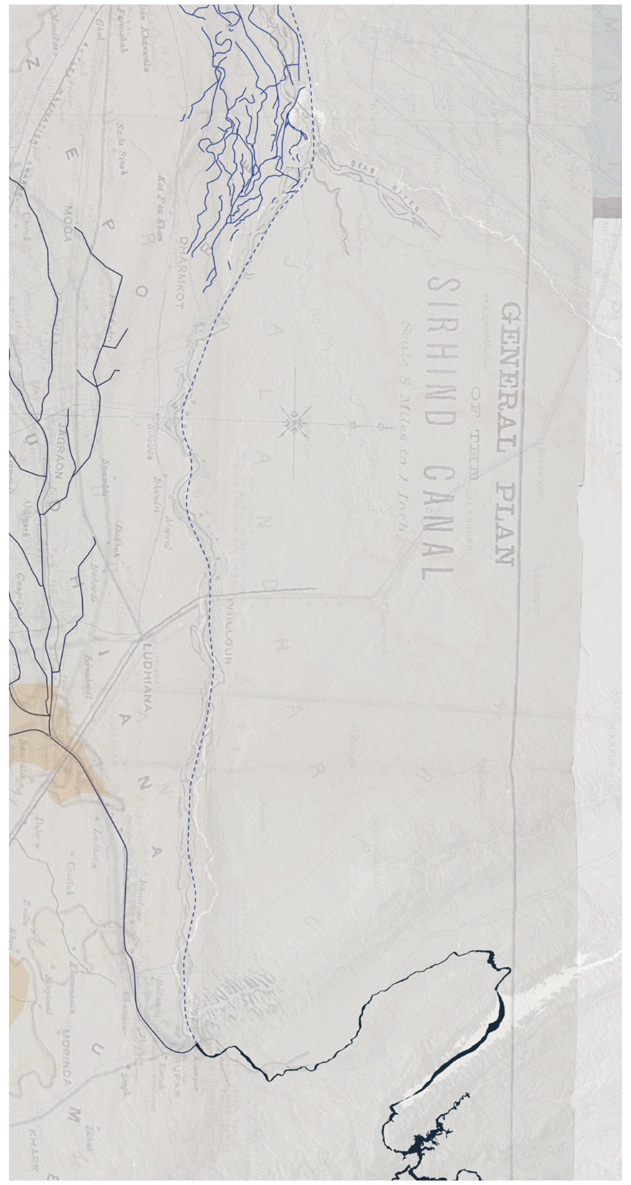
Hecht writes that scale is "emergent rather than eternal. But their situatedness and historicity do not detract from their reality. They do work in the world. They are performative. Scale is messy because it is both a category of analysis and a category of practice" He uses the term interscalar vehicle to describe subject matter which allows one to understand the complex interscalar history of the anthropocene.

The APM offers itself as an interscalar vehicle through its extrapolative disposition. To look at one APM is to think about its proportionality; to be proprtional is to think about the canal system writ large.

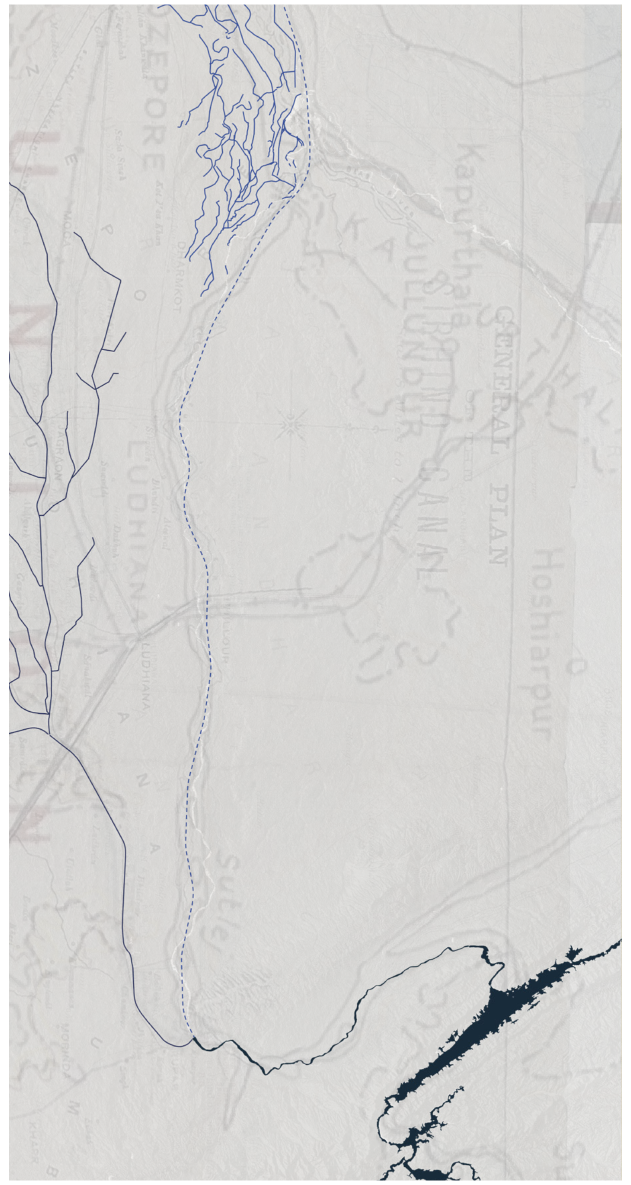
Crucially, Hecht's emphasis that scale is both anayltical and practice based speaks to how and why the APM operates isomorphically. The Adjustable Proportional Module is and was historically installed into pre-existing canal networks. The proportionality it offers allows canal systems which previously adhered to different irrigation rationalities to become transformed, thus acting as a 'software update'.

## Disposition:Reconstitution

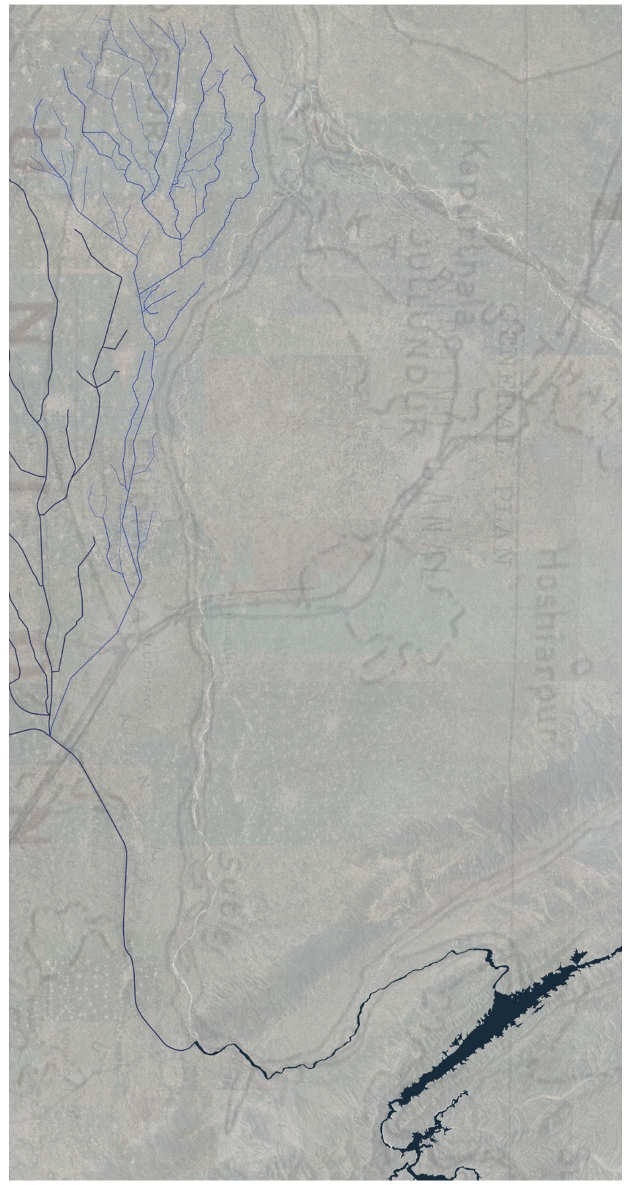
The APM outlet through interscalar relations of space and time



**1883**
The original canal did not cover the Firozpur region which, under Colonel Grey, was irrigated using inundation canals taking off from the Sutlej [Bhattacharya, 2019, 391].



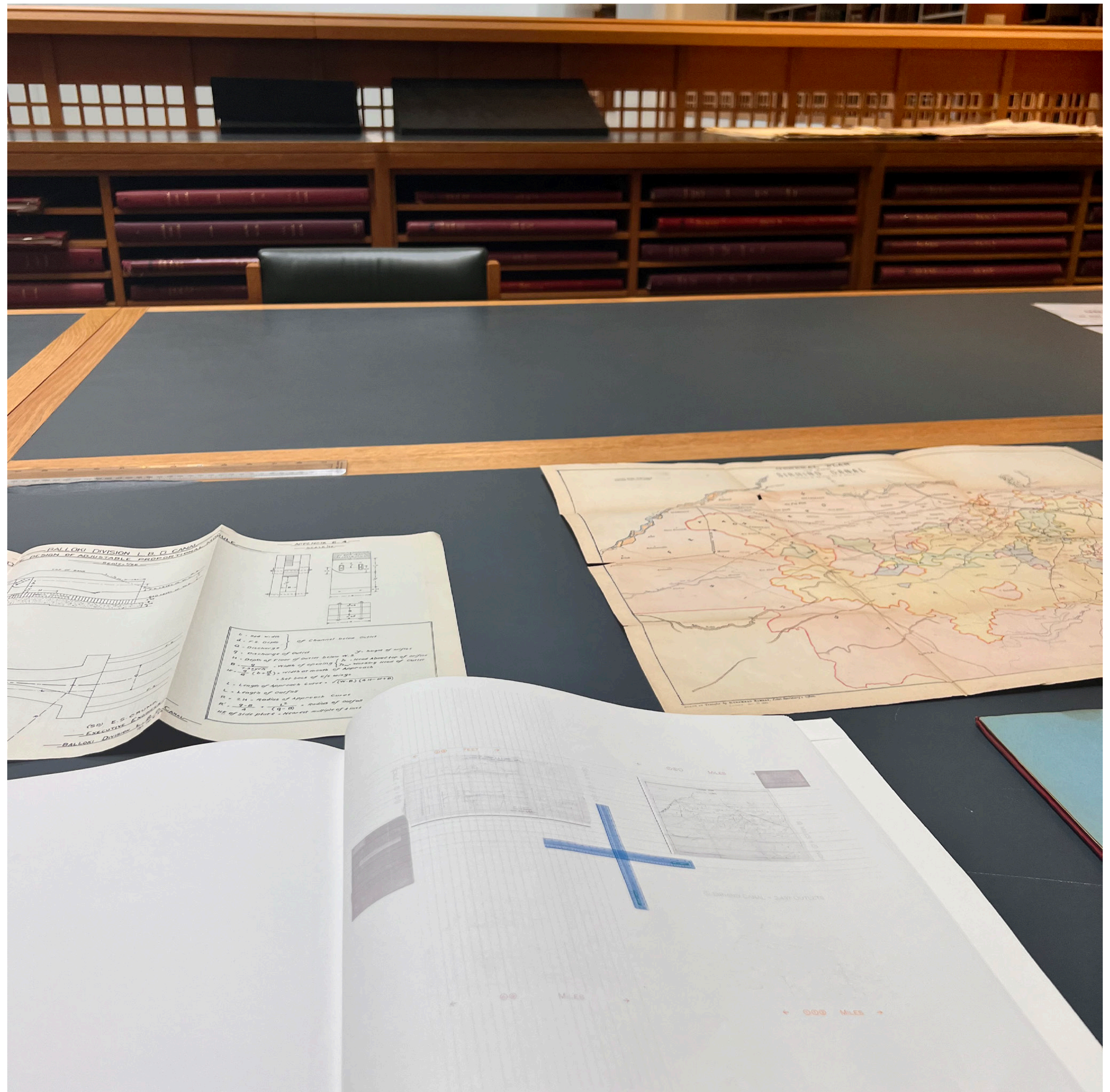
**1963**
With the Sirhind Canal utilising a greater ammount of water through APM's, Grey's Inundation Canals had little supply. Following the 1948 Indo-Pakistani water dispute, the Bhakra Dam was constructed with the aim to retain the river Sutlej's water within India.



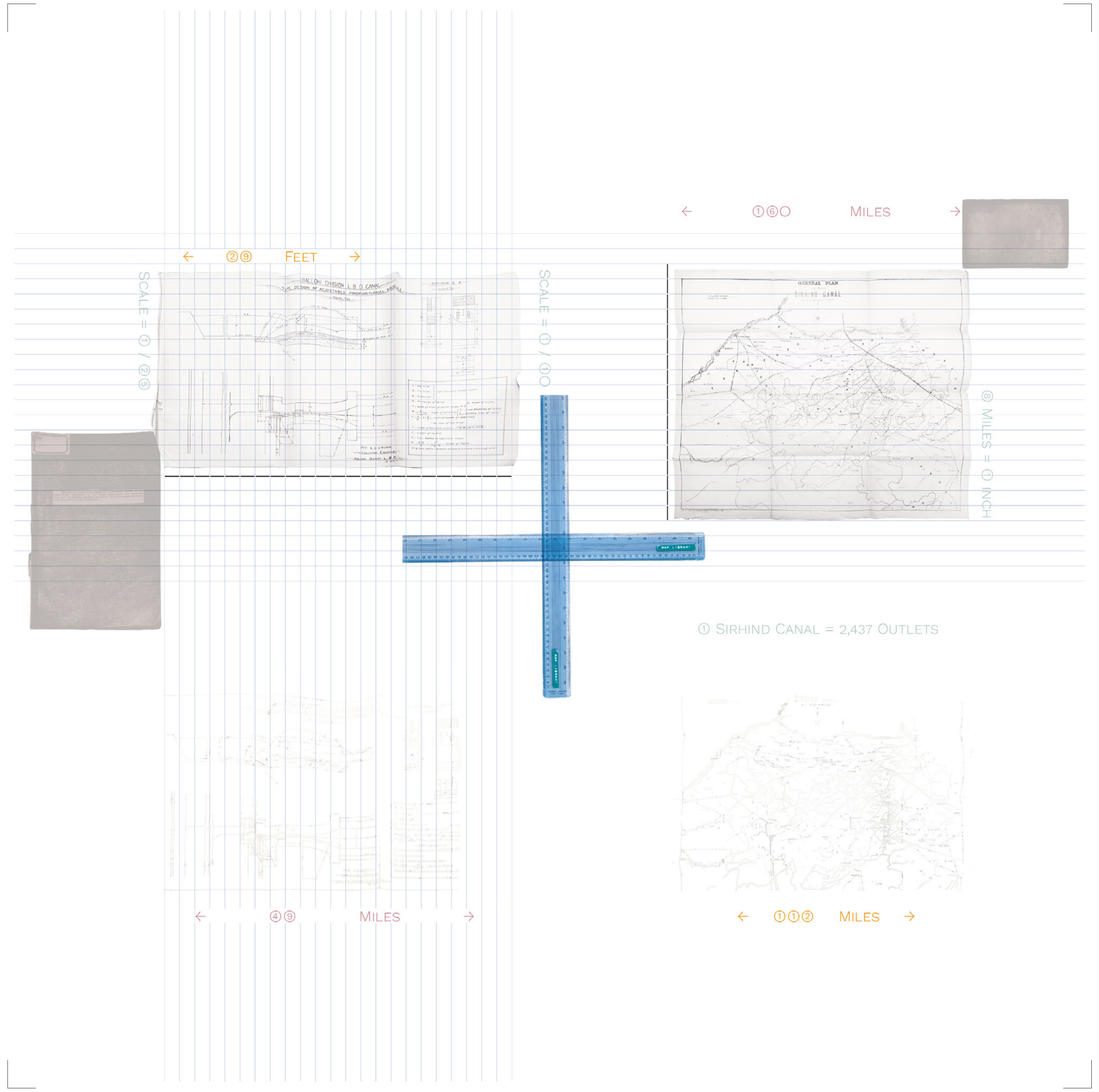
**Today**
The Indundation Canals were incorporated into the Sirhind Canal System as the new Sidwhan Branch. Use of proportional canal outlets (and some relining of canals) allows the inundation system to be transformed into capillaries of a pre-existing perennial canal [Singh, 1992].

# Scalar:Nodal

Seeing the canal's network logic through archival texts



Original APM Design (Crump, 1922) and Sirhind Canal Map (1882) within the British Library intersected with collage.


← ①⑥0 MILES →
← ②⑨ FEET →
SCALE = ① / ②⑤
SCALE = ① / ①0
⑧ MILES = ① INCH
① SIRHIND CANAL = 2,437 OUTLETS
← ④⑨ MILES →
← ①①② MILES →

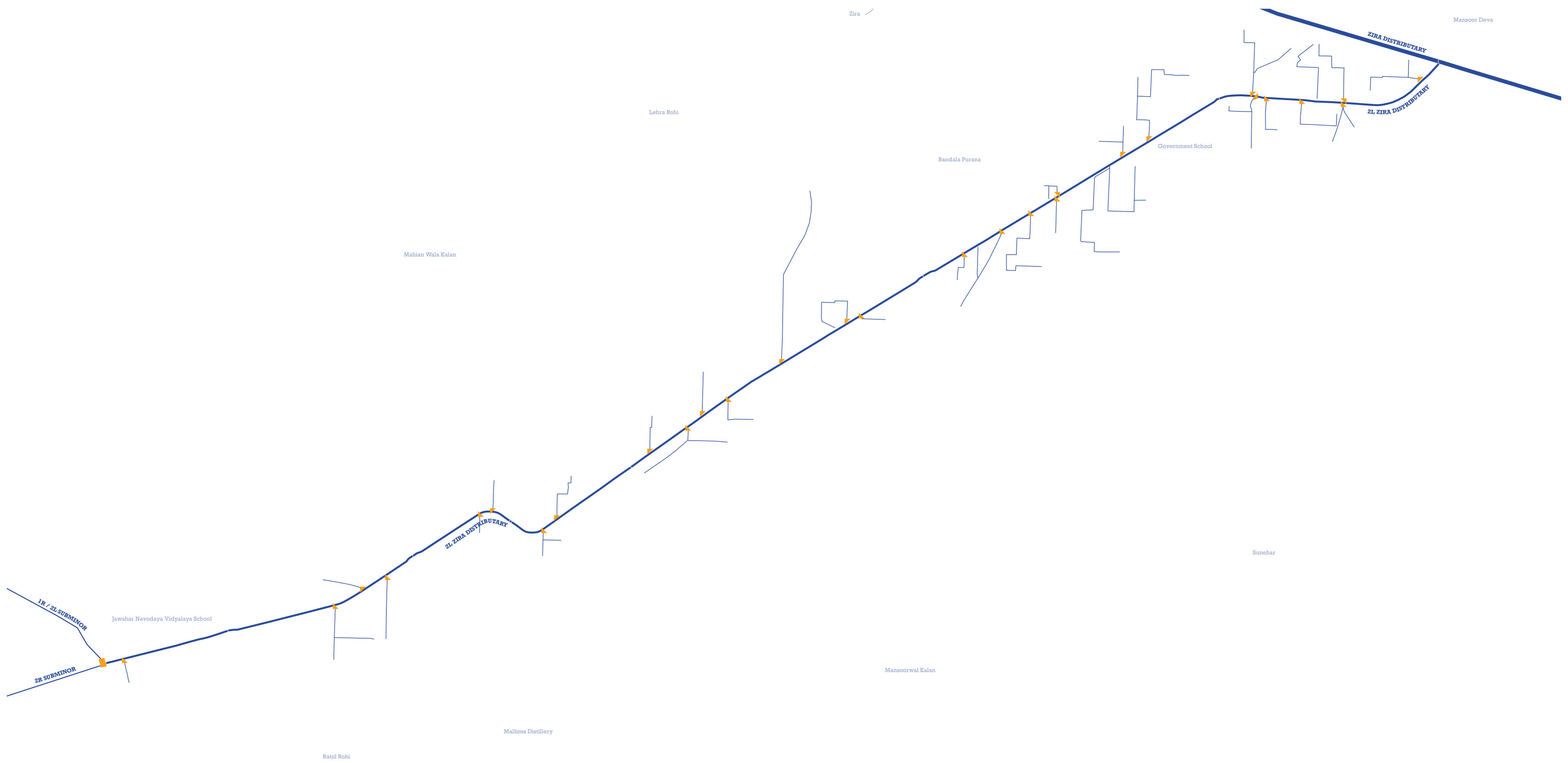
Collage juxtaposing the textual substrates of the system versus the individual outlet

1 Anon, 1882

2 Crump, 1922

# System:Field

The outlet as the terminus of the canal system


Zira
Mansoor Deva
ZIRA DISTRIBUTARY
2L ZIRA DISTRIBUTARY
Lehra Rohi
Government School
Bandala Purana
Mahian Wala Kalan
2L ZIRA DISTRIBUTARY
1R / 2L SUBMINOR
2R SUBMINOR
Jawahar Navodaya Vidyalaya School
Sunehar
Mansoorwal Kalan
Malbros Distillery
Ratol Rohi

500m

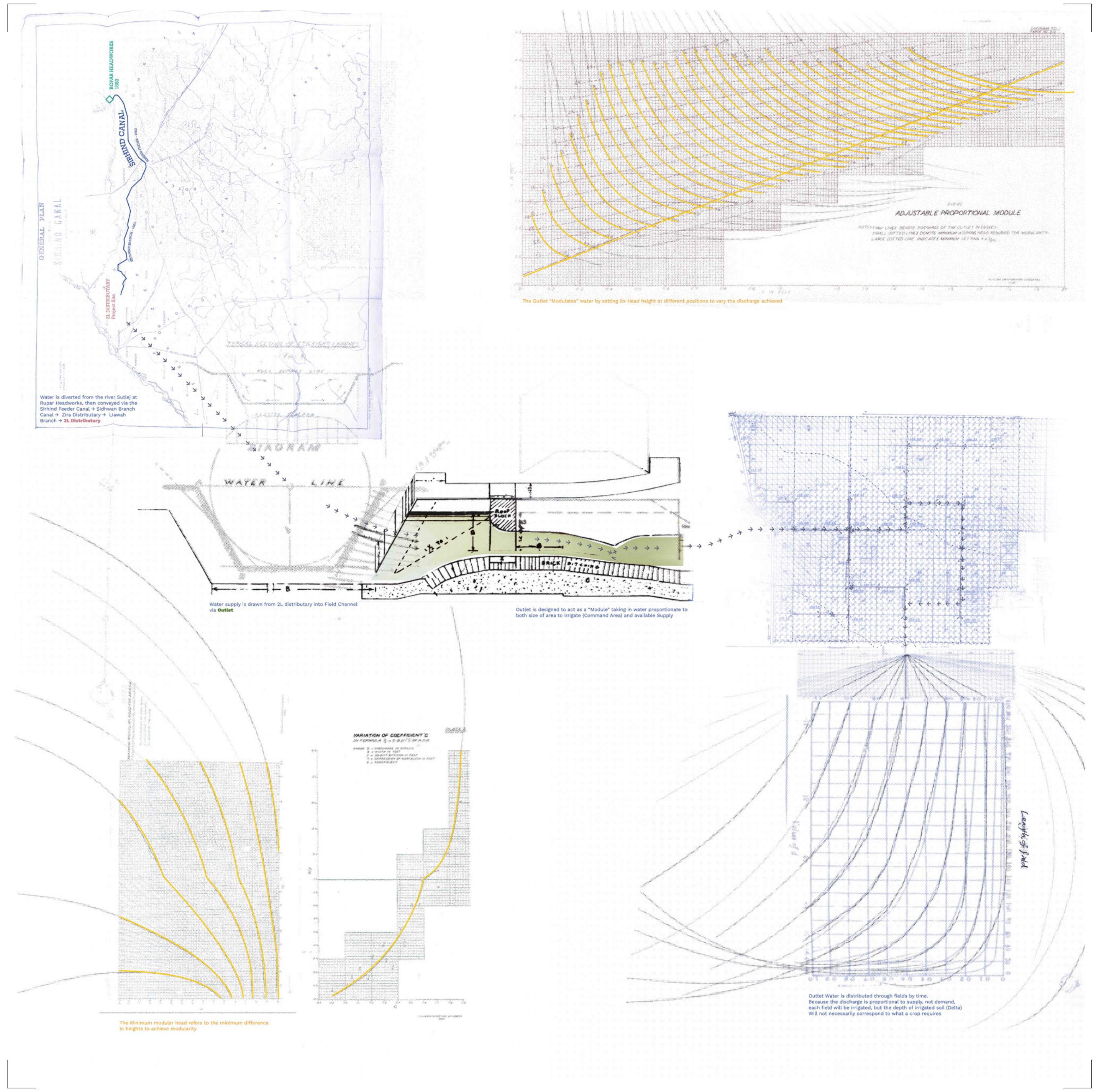
Canal; ▬ Distributary ▬ Minor — Subminor

Outlet; Flume — Field Channel

▬ Village / Town ▬ Non-Resi ▬ **Malboro**

Survey of India Open Series Map, 1997

2


2L DISTRIBUTARY
Project Site
ADJUSTABLE PROPORTIONAL MODULE
BRICK PITCHING
ROOF BLOCK
WATER LINE

Water is diverted from the river Sutlej at Rupar Headworks, then conveyed via the Sirhind Feeder Canal → Sidhwan Branch Canal → Zira Distributary → Liawah Branch → **2L Distributary**

The Outlet "Modulates" water by setting its Head height at different positions to vary the discharge achieved

Water supply is drawn from 2L distributary into Field Channel via **Outlet**

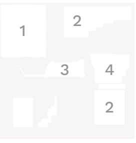
Outlet is designed to act as a "Module" taking in water proportionate to both size of area to irrigate (Command Area) and available Supply

Outlet Water is distributed through fields by time.
Because the discharge is proportional to supply, not demand, each field will be irrigated, but the depth of irrigated soil (Delta) Will not necessarily correspond to what a crop requires

The Minimum modular head refers to the minimum difference in heights to achieve modularity

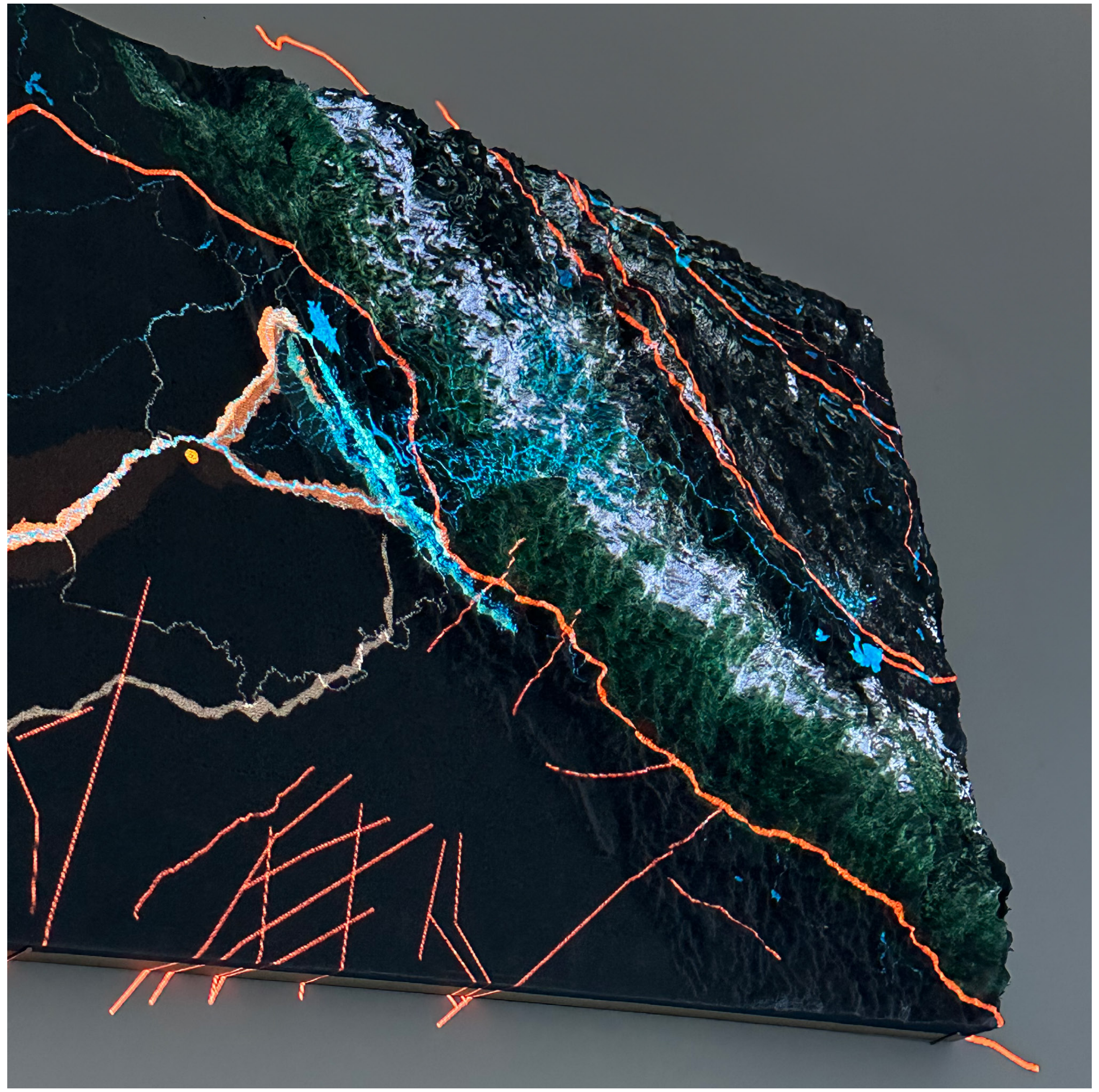
Collage showing the emergent system with the outlet as the generator

1 Anon, 1882
2 Sharma, 1940
3 Crump, 1922
4 Gyan, 2021



②

## Flow : Attenuation



Model photo of Indus/Himalayan
Topography with projected annotations

## Introduction

*The soil is usually rich alluvium, often of great depth, [...] The configuration therefore is such as to lend itself admirably to the construction of irrigation-works [...] East of the Central Punjab there was a great tract of more than 1 million acres of splendid land lying waste for want of water that could not be supplied from any source near at hand*
→ John Benton, 1916

*The nearest approach we could get to the conditions beneath het soil was by considering the flowing water ot be a very viscous fluid such as pitch or treacle. We could then come to a solution by hydrodynamic methods. it could be proved that each article performed a circle about its mean position. As we proceeded downwards the radius decreased exponentially, and a point was reached where there was no velocity at all. But the difficulty remained that with a viscous liquid no simple solution could be obtained. Therefore we had to adopt empirical methods, say by examining the history of the water-table. Unfortunately existing data were not very reliable.*
→ Wildson, 1926, 10

The Punjab's contemporary soil/geology arose from an ongoing process of Alluvial fanning, forming both fertile soil and problematics for agriculture, which canal construction has sought to address. The identification of this space as a 'resource' that was 'lying waste' [Benton, 1916] has also produced an abstracted view of the geology. Understanding the gap between the geology as it exists and operational understanding highlight the problems with the APM/Canal System design.

The epistemological gap between the models of the Punjab utilised by engineers and the geology as it is can be cross referenced against one another. The geology of the Punjab can be understood as a witness [Meillassoux, 2008], having recorded the forces and processes that creates the contemporary landscape. This record can be compared to the archival record of the British Engineers who intervened in this landscape. By juxtaposing the textual and the geologic, modernist industrial design ideals and the politico-economic principles they intended to serve are shown to be 'subtended' by geology, and the treatment of the Punjab as a vast alluvial tabular rasa ready for agriculture was, and is, in tension with the geologic reality.

Between the real and the technoscientific vision lies representation. Representation both abstracts the real and illuminates it. Through this project, conversations with my tutor Elena Luciano Suastegui highlighted the ongoing issue of aesthetics in geology and earth sceince. In seeking to form an environmental practice, I have been acutely aware of this tension. Kathryn Yusoff's call or "Epochal Aesthetics" [Yusoff, 2017] has been particularly insightful as a method to make visible the consequences and 'unthought' of canal colonisation.

**Keywords**

→ Alluvial
Loose material (clay, sand, silt) deposited by the flow of water

→ Anthropocene
Proposed geological epoch denoting a period where human activity has had geologically transformative impact

→ Aquifer
A strata of permeable sediment through which water can attenuate or be stored

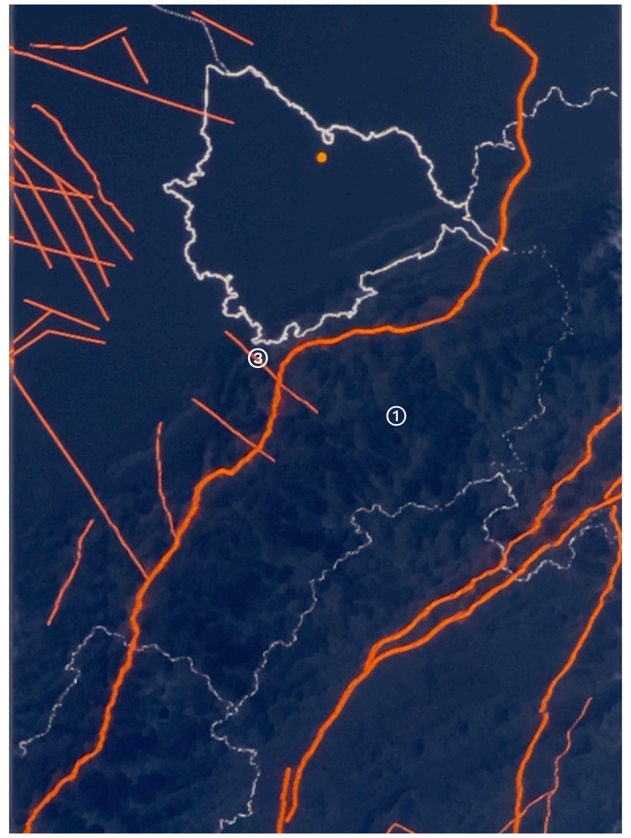
→ Sediment
matter (stones, sand, pebbles) broken off from geologic features and weathered down

→ Unthought
That which was not thought of. Within the Anthropocene, referring to consequences and impacts of human activity previously not considered or understood [Yusoff, 2017]

→ Witness
Within geology and soil, undersanding that the material substrate being shaped by historic geo-engineering can today be interpreted as a record of that activity [Meillassoux, 2008], [Schuppli, 2020]

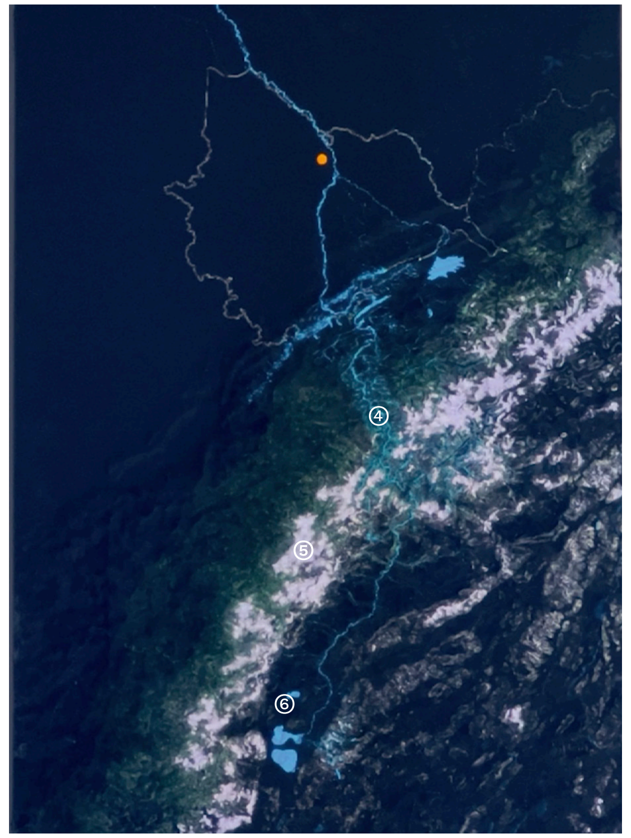
# Sediment:Soil

The Geologic processing of the Punjab

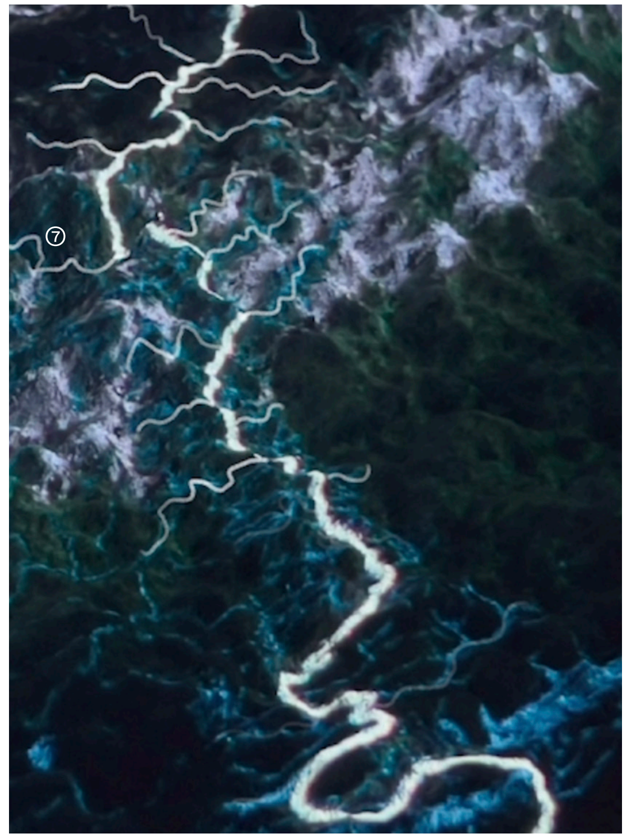


**Sediment**
The Himalayan mountain ① range are the result of the colliding Eurasian and Indian tectonic plates. Below the Himalayan range are the sedimentary Siwalik hills ③, **Sutures** remain active parallel to the plate collision with **thrust** faults running perpendicular [Hubbard Et al, 2021].

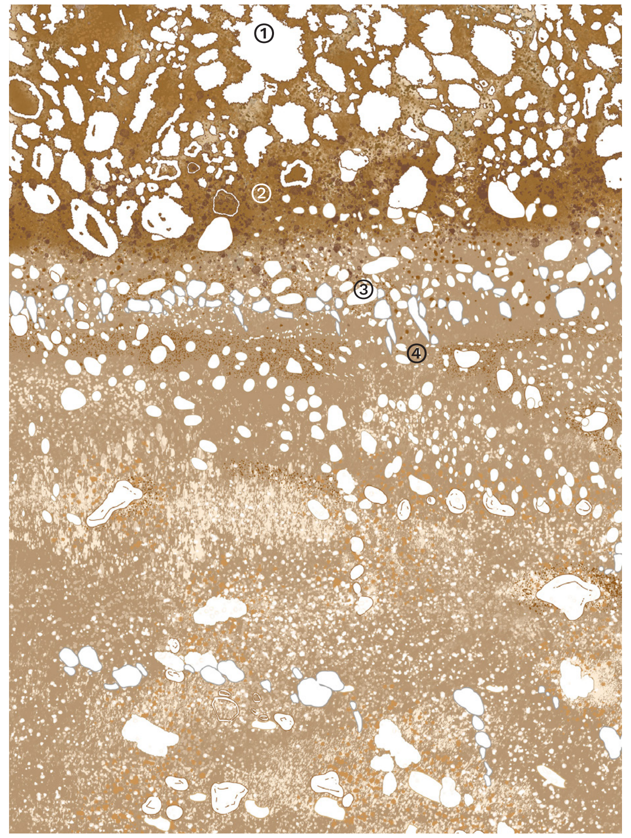
The river Sutlej ④ begins as an ephemeral stream flowing from lake Rakshastal, Tibet ⑤.



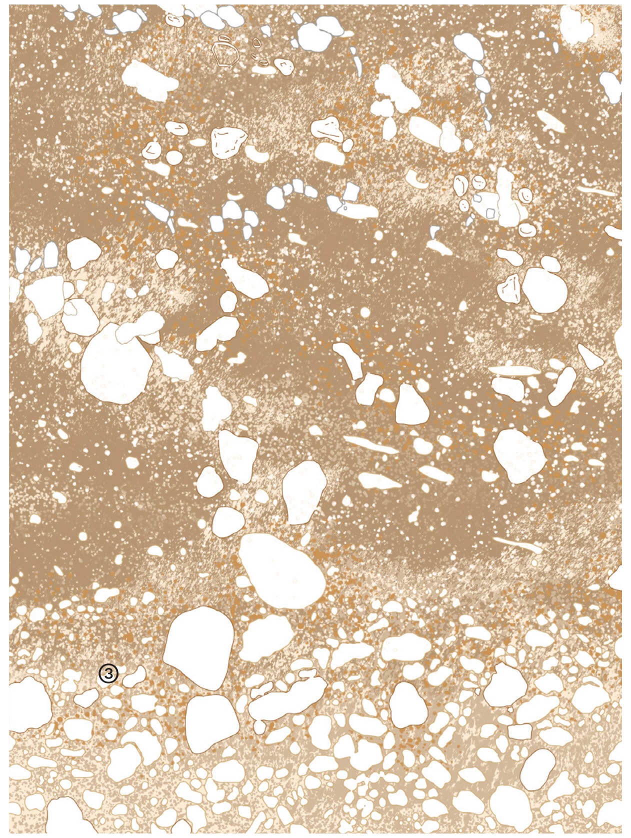
Moist air settles and condenses to form snow and glacial formations ⑥. Glacial melt produces seasonal tributary rivers which dislodge sediment from the rock face ⑦ [Sharma, 1991]. Rain pours into the flow as the monsoon annually interacts with the high altitude, compounding the precipitation. The Sutlej river flows outwards into the comparatively flat plains of the Punjab [van Dijk, 2016]. The sediment carried along in turbulent motion begins to deposit. The Sutlej river formed as a trunk river, compounding into this alluvial fan.



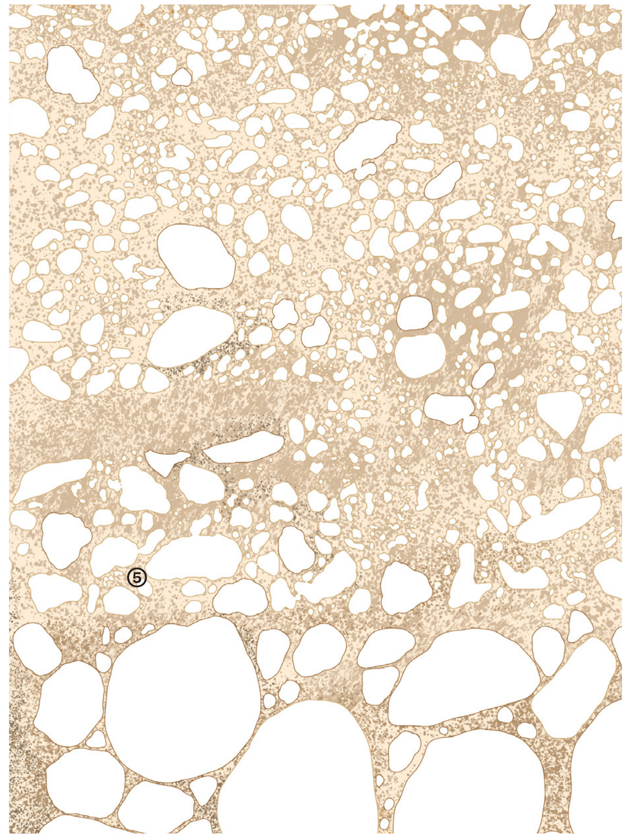
The tectonic forces which forged the Himalayas are still active and in the Punjab plains can lead to sudden changes in river direction. When this happens, an area once flowing with water is left with idle waters leading to clay deposits forming, covering over the sediment previously deposited. As the flow of water in the alluvial fan oscillates over long periods, the result is geological strata of sedimentary deposits, clay laminated layers [van Dijk, 2016], layering over one another. The sedimentary deposits known as "paleochannels" are porous and thus able to retain water, forming aquifers.



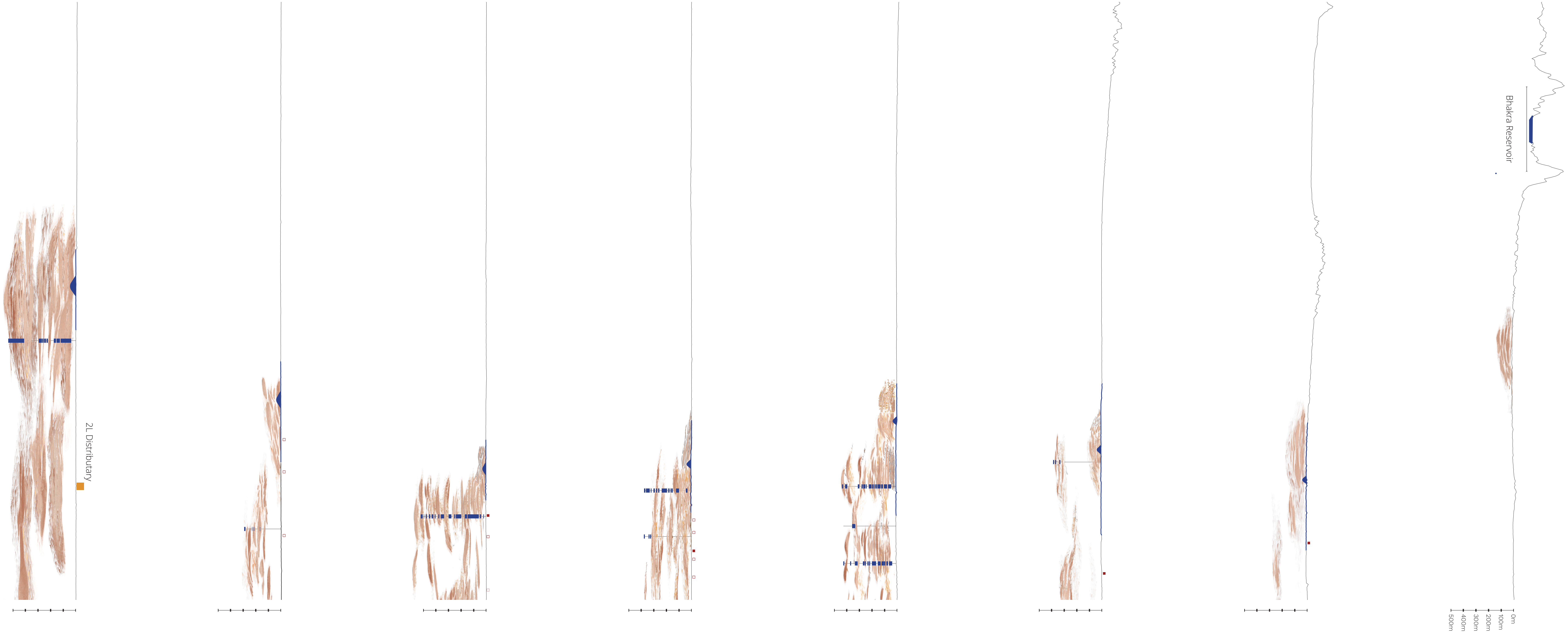
**Soil**
Deposited Sediment ① (Parent Material) [Hoffland et al, 2004] is weathered by and microbes releasing compounds. Over time, microbes decay who then release acids and proteins that further break down the sediment. They also deposit organic material which is the foundation for humus ②.



Soil weathering increases in depth through continued watering and weathering. With depth the pedogenetic processes change, which leads to distinct soil horizons ③ [Sharma et al, 2020].



Regular attenuation of water through the soil, according with monsoonal overflowing of the river, leaves calcium deposits ④. Within deeper soil horizons, calcium deposits can lead to cementation, binding sediment together ⑤. The water attenuates down into the aquifers, with a movement known as tortuoisity [Amien et al, 2019].


2L Distributary
Bhakra Reservoir
500m
400m
300m
200m
100m
0m
10km
Vertical scale multiplied by 10x
Topographical Profile
Alluvial Aquifer
Feeder / Sidhwan Main
Sidhwan Distributaries
Other Branches
Lithological aquifer depths
Sutlej River Profile
Historic Sutlej Flood Basin

Sections through Sidhwan Branch Region (See Chapter 1 Plan for lines of intersection).The historic Alluvial fan can be seen as the alluvial aquifers grow in size and density with distance from the Siwalik Hills.

Lithological Data from India WRIS

# Abstraction:Dispossession

### Modelling Soil and Missing Substrates

The Punjab Canals were designed in accordance with an operational model that applied a reductionist lens to the nuanced underground architecture of water flow.

Darcy's 1856 'law' rationalised the behaviour of attenuation as uniformly proportional to a soil's pressure, permeability, and depth. Many engineers working on canal irrigation acknowledged the limitations of Darcy's law [Wilsdon, 1926] but critique was orientated towards fine tuning a mathematical representation.

Within the Punjab Engineer's congress a recurrent antagonism existed, between published papers attempting to apply a rationality to the behaviour of water while others point out factors overlooked. This tension evokes Kathryn Yussoff's conception of the "missing substrate" - that material flows which were ignored or abstracted through anthropocenic activity transpire to have had immense consequences today. Yussoff writes that: *The geologic and how it comes to matter beyond representational genres as a sensibility of time as well as a quality of materiality is firstly an archeology of the unthought; an arena of building and accumulation that has been rendered invisible and contractually mute. In this zone of agitation between matter, what comes to matter and that which has seemingly escaped material memory, aesthetics become a crucial space for engaging with geologic force and time and its proposition to stand against the architectures of agency (and reason) that brought the Anthropocene into being.* [Yusoff, 2017]

### Reduction:Resource

Elden [2013] argues that space is too often conceptualisded as flat 'areas' with disregard for the vertical. The Punjab's alluvial plains were understood as a resource to extract from. Pereira refers to this as the Axiomatic Earth, where: "*All aspects of the earth are made into resources once they are translated into datasets—the epitome of what Heidegger described many years ago as the age of the world picture, where the entirety of nature is framed as a standing-reserve (bestand)*" [Pereira, 2015, 2].

Pereira's linkage of resources and data reflects the rationality of the crump outlet - where formulaic relationship can ensure the quantification of unstable water-and-silt into a smooth, predictable flow. The substrate is therefore not so much missing as it is disregarded, simplified as something to take from. Where the vertical is represented in mapping then, it is done so in the service of extraction.

To move beyond axiomatic/reduced representation of the below ground is therefore to map the past actions it has been subject to. Soil is more than the axiomatic representation. The subsurface is a witness to the historic forces that it has been subject to. Targulian and Goryachkin [2004, 2] argue that soil can be seen to posess memory: "*Soil memory is both: (i) a capacity of the complex multiphase soil system to record environmental phenomena through pedogenic processes acting in situ in each point of the land surface of the Earth, and (ii) a record itself of this environmental and process information on the resistant soil solid-phase carriers in situ*".

### Aesthetics as Engagement: Learning to read the soil

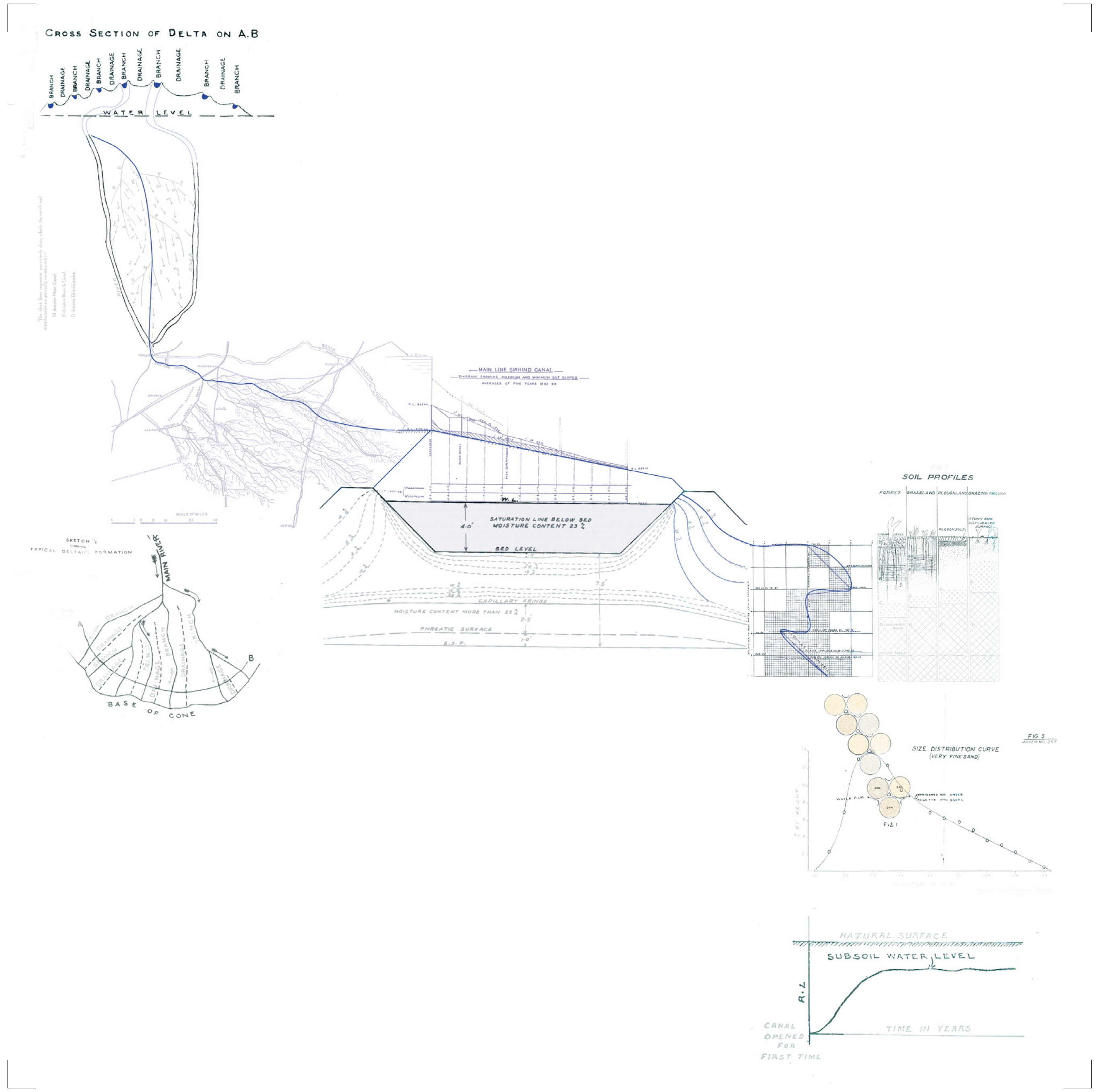
Abstract representation of soil and strata is also borne out of fundamental issues of visuality. To sample is to extract: it may model or speak to the conditions it is from, but is no longer within those conditions. A borehole will result in partially distorted samples, a thin slice through soil while disrupting its structure.

I have been keen to avoid pitting historic knowledge against a 'fuller' picture of today. An abstracted conception of the vertical continues within geological institutional praxis. And while increased sampling would greatly increase understandings, this affords only a one dimensionality.

Collating information that is expressed through different resource oriented 'datasets' the process of drawing the geologic has allowed me to understand the site conditions in greater detail while also producing an expressly accessible visual of the space that is concealed below ground.

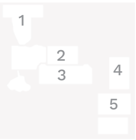
For instance by situating remote sensing studies that map paleo channels alongside public litholog data an outline of the underground volumetric space emerges. When working through disparate geologic studies written for academia and for industry alongside soil pedogenesis studies, a collated visuality is possible.

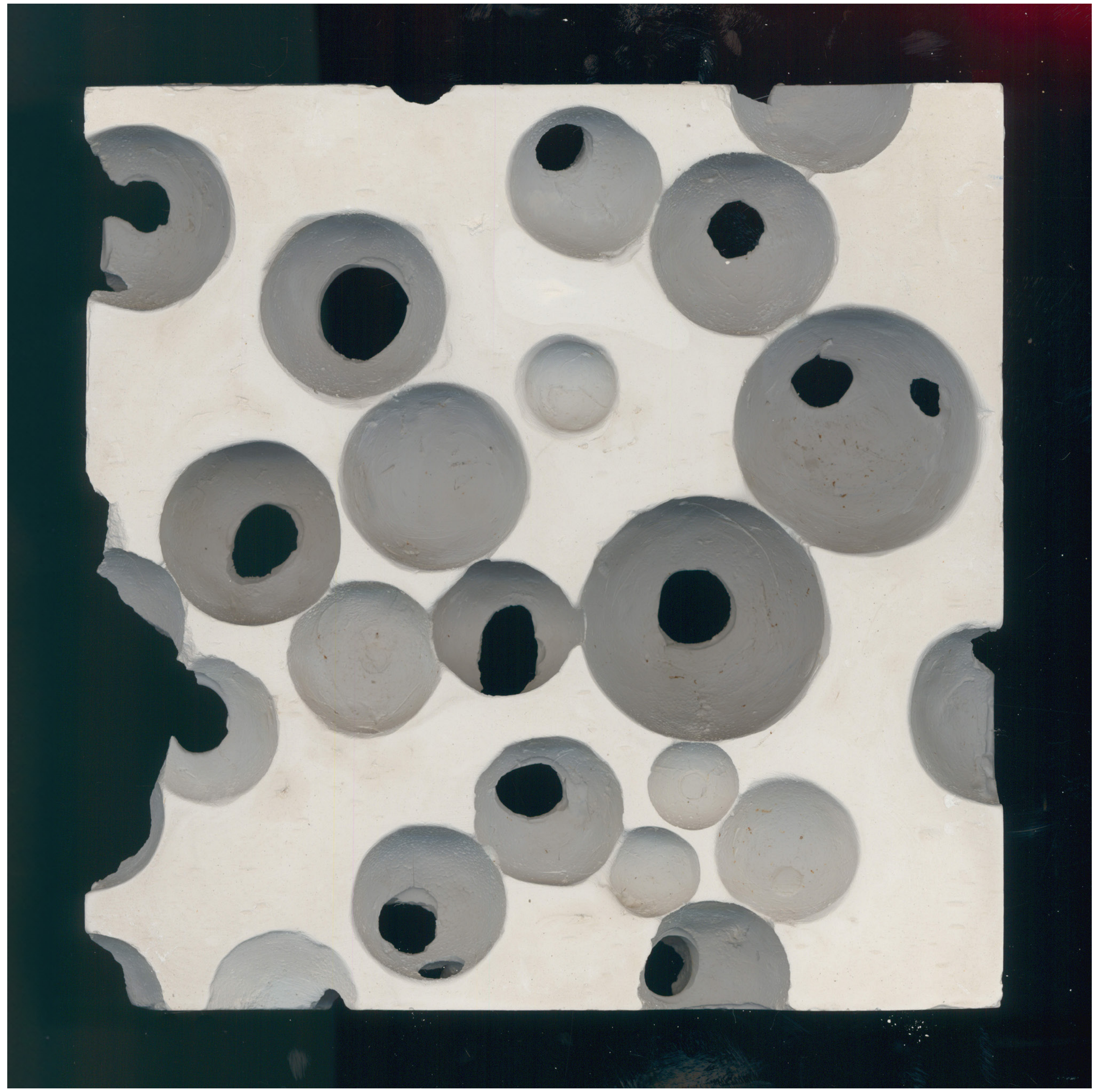
Such drawings are also abstracted, also operational, but done so in the service of understanding the soil rather than to illustrate certain ideals. The drawings seek to refocus imaginations of the soil, so that the “vast alluvium” and uniform subsoil flows which the Crump adjustable proportional works to us no longer seen as a rational ideal.

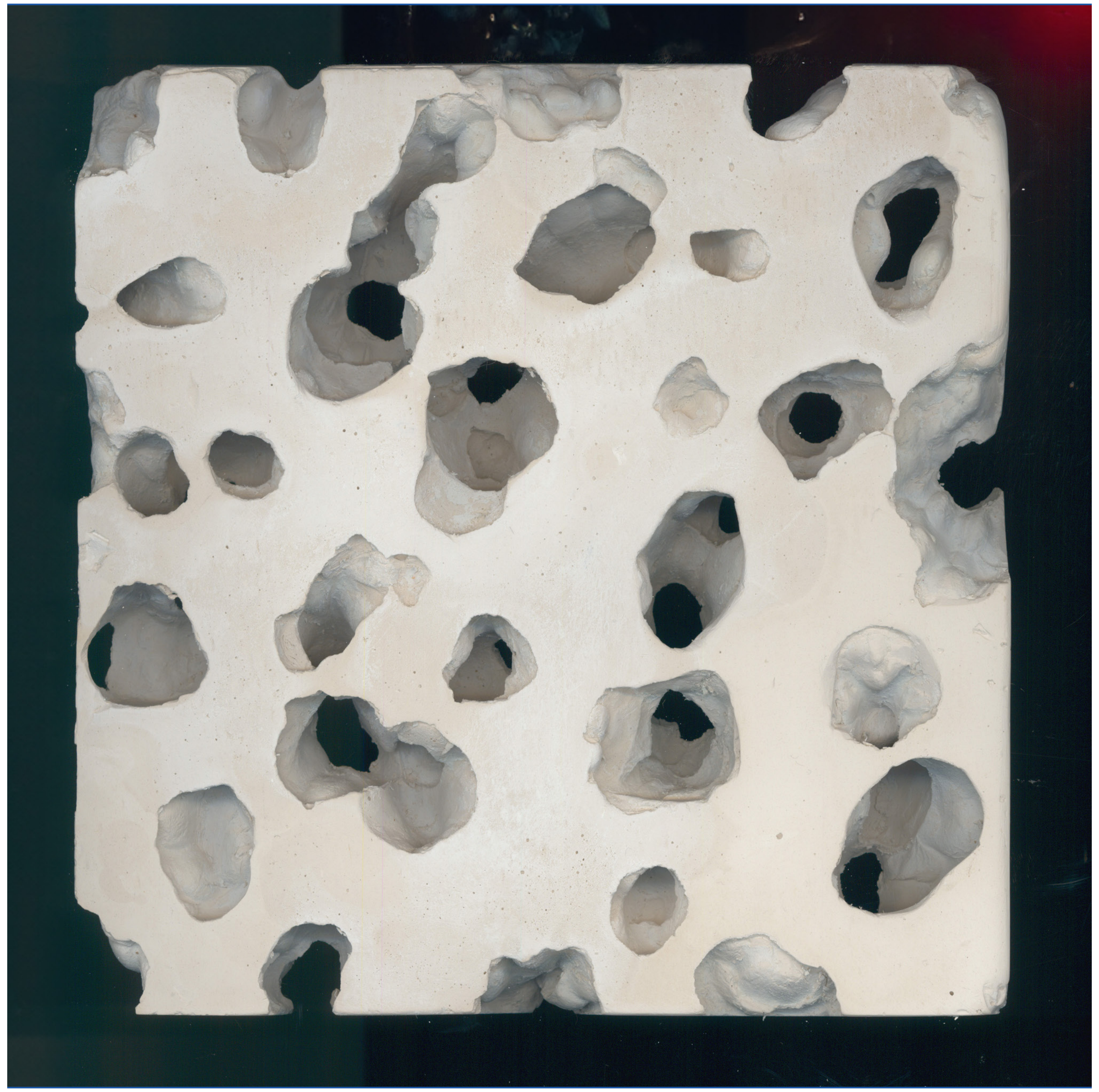

Cross Section of Delta on A.B
Water Level
Main Line Sirhind Canal
Diagram showing maximum and minimum silt slopes
Averages of five years 1893-98
W.L.
Saturation line below bed moisture content 23%
4.0'
Bed Level
Capillary fringe
Moisture content more than 23%
Phreatic surface
B.S.P.
Base of Cone
B
Soil Profiles
Forest
Grassland
Ploughland
Grazing ground
Fig 5
Size distribution curve (very fine sand)
Water film
Fig. 1
Natural Surface
Subsoil Water Level
R.L.
Canal opened for first time
Time in years

Collage re-constitutiting archival representations of the Punjab's alluvial landscape and the Canal's intervention within it.

1 Wadley, 1913, 11
2 Buckley, 1905, 41
3 Sharma, 1940, 28
4 Gorie, 1938, 27
5 Vadhianathan, 1942, 27



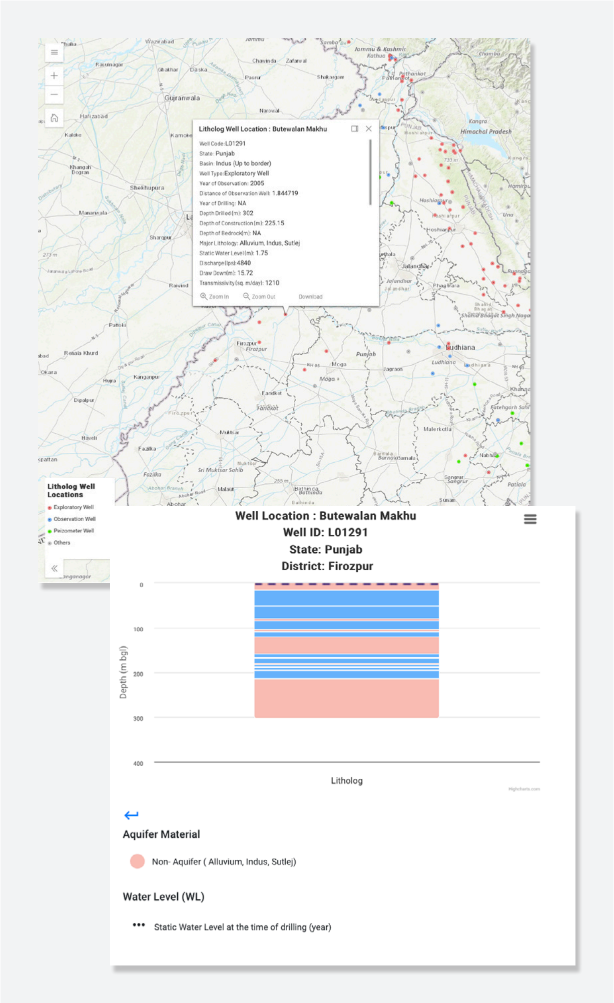




Gypsum Casts showing the operational understanding of soil structure (not to scale), from the early 20thC to today.

# Abstraction:Dispossession

Contemporary ways of reaing the vertical, and their limitations



Litholog Well Locations
Exploratory Well
Observation Well
Peizometer Well
Others
Depth (m bgl)
0
100
200
300
400
Litholog
Highcharts.com

Well Location : Butewalan Makhu
Well ID: L01291
State: Punjab
District: Firozpur

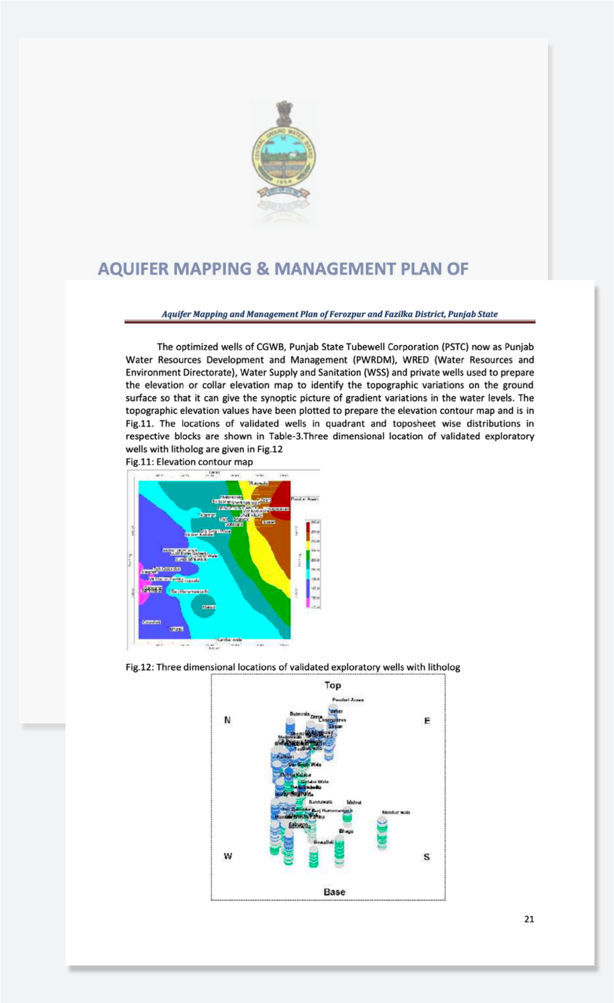
Aquifer Material

Non- Aquifer ( Alluvium, Indus, Sutlej)

Water Level (WL)

Static Water Level at the time of drilling (year)

**Lithological Data**
Lithological data is publicly available at https://indiawris.gov.in/wris/#/Litholog. A litholog provides information on the vertical, linear makeup of ground at the drilling point. Further, the publicly available data do not distinguish on geological composition, instead highlighting if the band is aquifer or non-aquifer.



AQUIFER MAPPING & MANAGEMENT PLAN OF

*Aquifer Mapping and Management Plan of Ferozpur and Fazilka District, Punjab State*

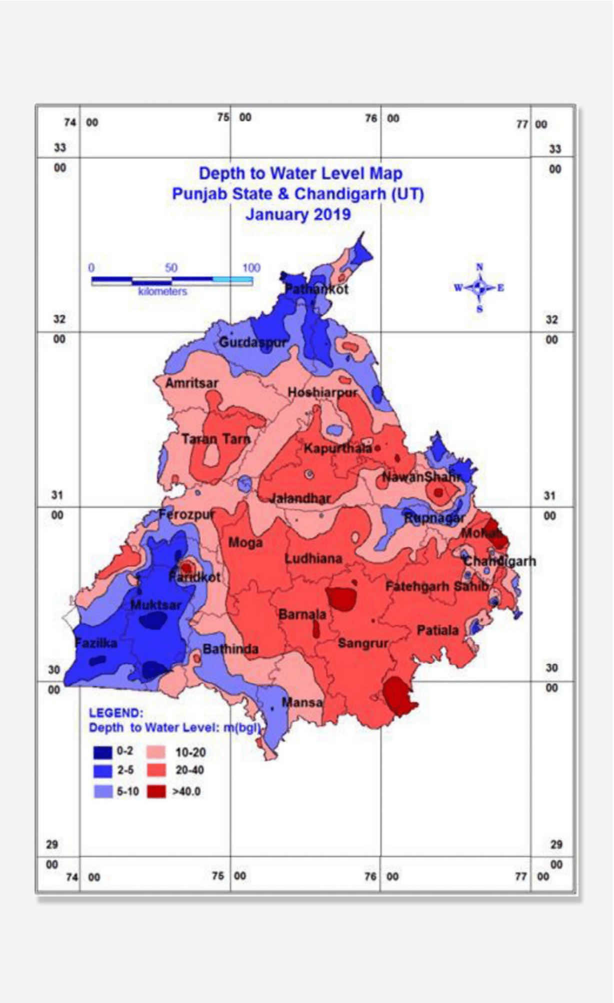
The optimized wells of CGWB, Punjab State Tubewell Corporation (PSTC) now as Punjab Water Resources Development and Management (PWRDM), WRED (Water Resources and Environment Directorate), Water Supply and Sanitation (WSS) and private wells used to prepare the elevation or collar elevation map to identify the topographic variations on the ground surface so that it can give the synoptic picture of gradient variations in the water levels. The topographic elevation values have been plotted to prepare the elevation contour map and is in Fig.11. The locations of validated wells in quadrant and toposheet wise distributions in respective blocks are shown in Table-3.Three dimensional location of validated exploratory wells with litholog are given in Fig.12

Fig.11: Elevation contour map

Fig.12: Three dimensional locations of validated exploratory wells with litholog

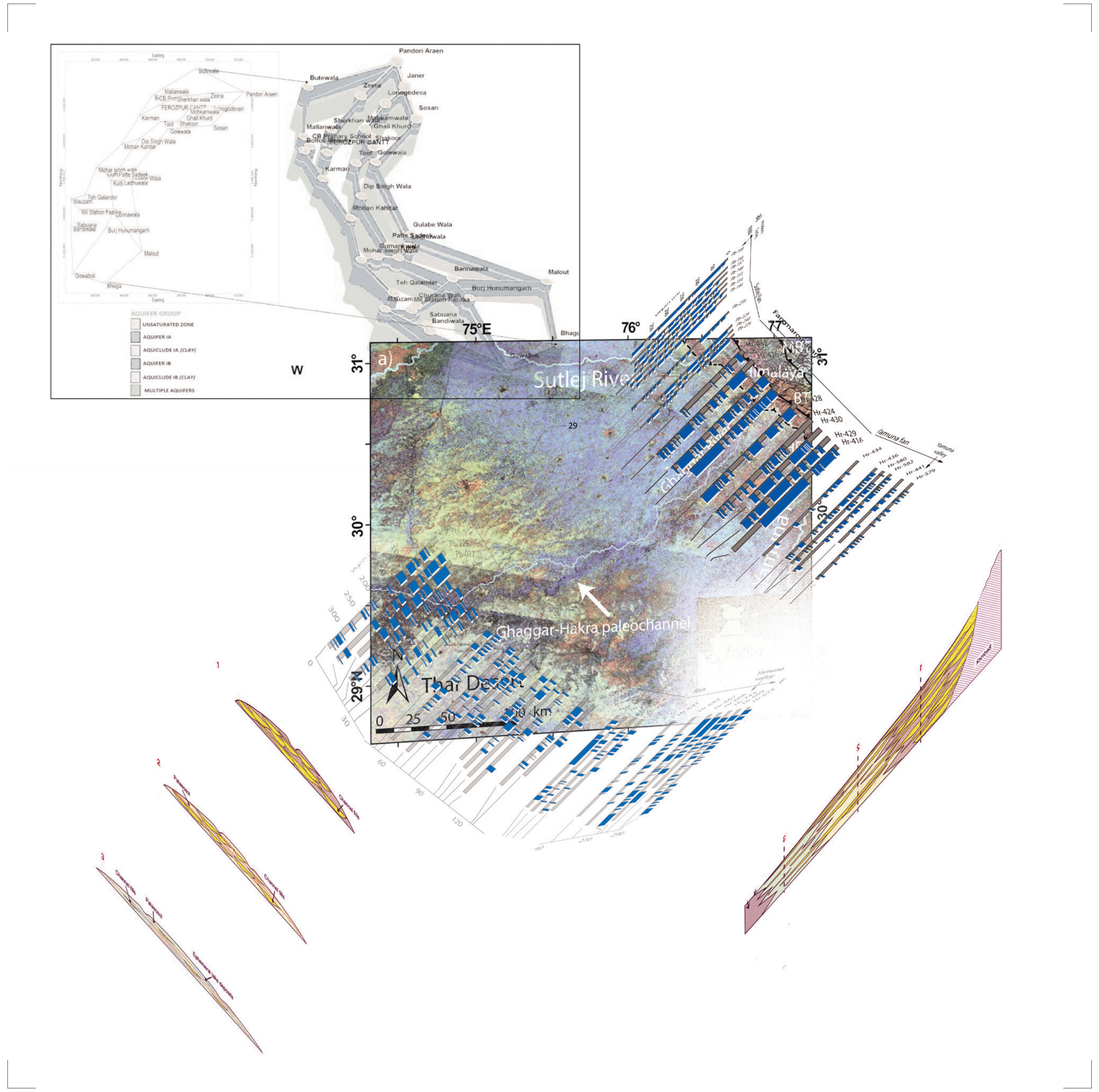
Top
N
E
W
S
Base
21

**Fence Diagrams**
Punjab districts publish annual water level reports which extrapolate from lithological data to produce "fence diagrams" showing the change in band depths other space. This is limiting as it relies on the frequency of Lithologs to form a quasi-3d understanding, and does not speak to the directionality of aquifer flow.



Depth to Water Level Map
Punjab State & Chandigarh (UT)
January 2019
0
50
100
kilometers
Pathankot
Gurdaspur
Amritsar
Hoshiarpur
Taran Tarn
Kapurthala
NawanShahr
Jalandhar
Rupnagar
Ferozpur
Mohali
Chandigarh
Moga
Ludhiana
Faridkot
Fatehgarh Sahib
Muktsar
Barnala
Patiala
Fazilka
Bathinda
Sangrur
Mansa
LEGEND:
Depth to Water Level: m(bgl)
0-2
2-5
5-10
10-20
20-40
>40.0
74 00
75 00
76 00
77 00
33 00
32 00
31 00
30 00
29 00

**Depth to Water Table data**
Depth to water table is published by the Central Ground Water board annually, showing the depth to water table pre and post-monsoon. This data does not help understand the aquifers that farmers rely on, as water table depth bares limited relation to the ammount of water that is held within an aquifer.



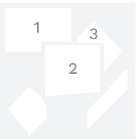
W
a)
Sutlej River
Himalaya
Ghaggar-Hakra paleochannel
Thar Desert
75°E
76°
77°
31°
30°
29°N
0
25
50
km

Collage. Contemporary geologic aesthetics continue to obscure and misconstrue the vertical.

1 Aquifer Plan, 2017, 34

2 van Dijk et al, 2016, 2016, 3

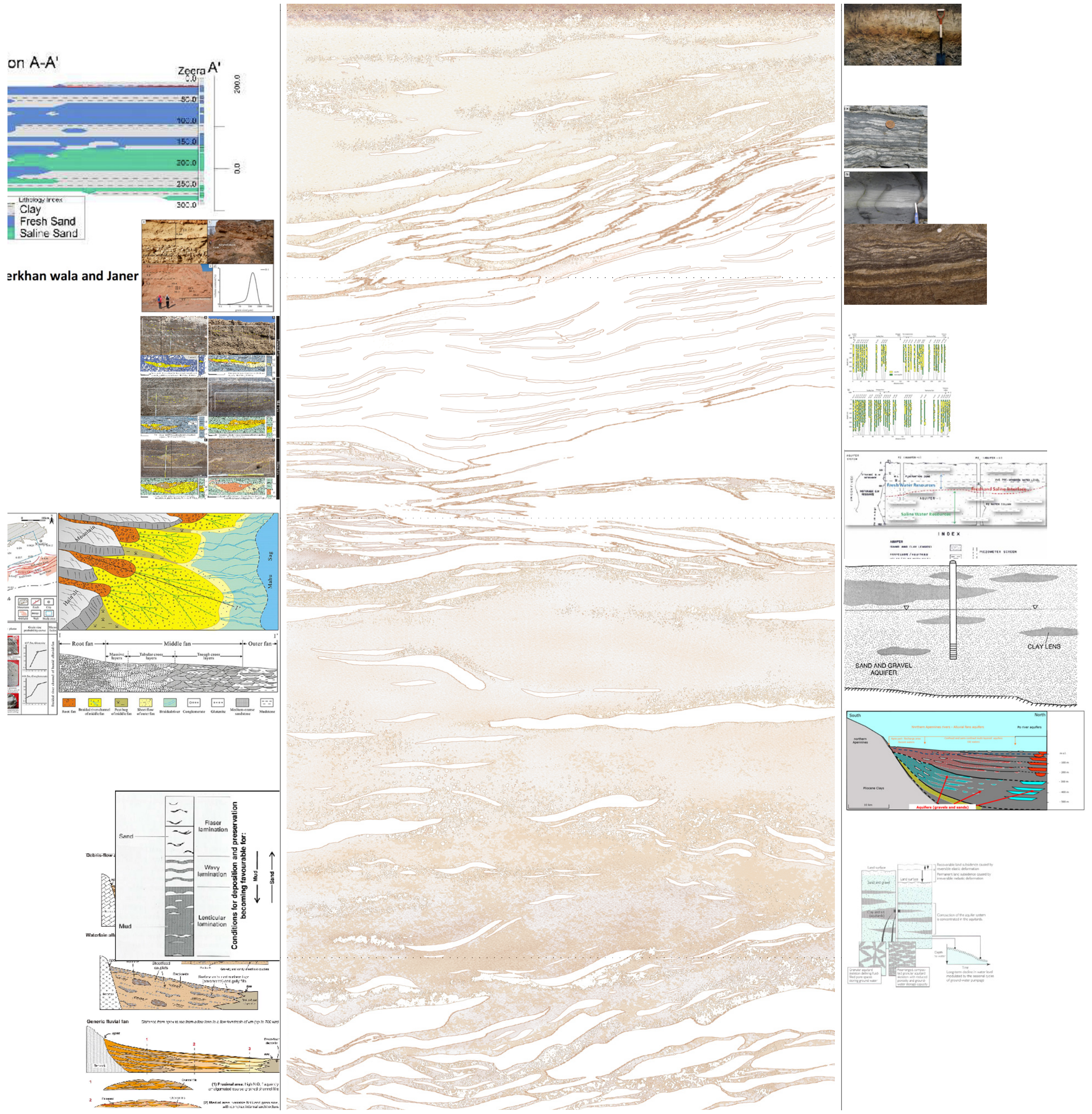
3 van Dijk et al, 2016, 2016, 13

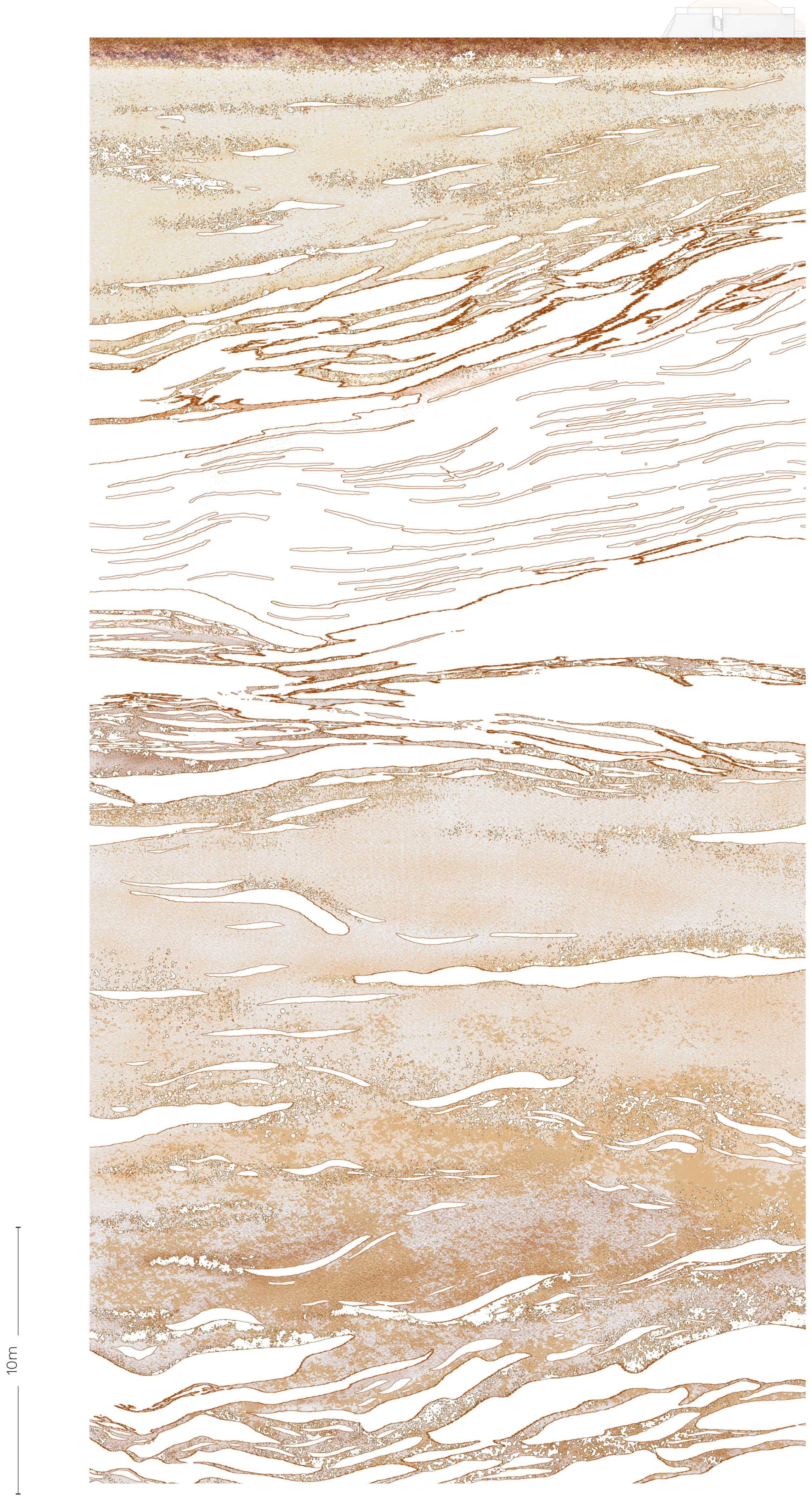


Flow:Attenuation

# Sedimentary Drawing

Producing a representation of the subsurface drawn from a sedimentary selection of sources


on A-A'
Zeera A'
Clay
Fresh Sand
Saline Sand
erkhan wala and Janer
CLAY LENS
SAND AND GRAVEL AQUIFER



**Outlet for Scale**

**Soil Horizons** - see page 59

**Aquifer 1a**
Unconsolidated alluvial deposits interspersed with clay laminations

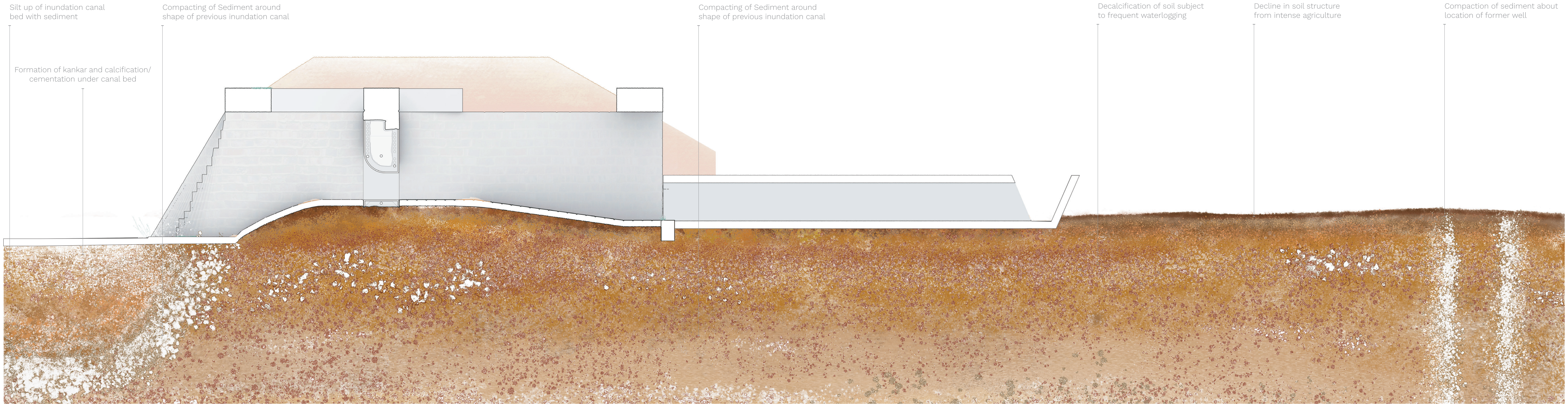
**Clay strata**
Dense lenticular deposits of clay interspersed with layers of silt and sediment aquitard, allowing some water to attenuate through

**Aquifer 1b**
Unconfined aquifer recieving freshwater from aquifer 1a through aquitard layer. Greater levels of cementation of sediment with calcium deposits bonding particles together. Clay laminations interspersed.

Left: sources used in developing aquifer representations. Right: Section through alluvial aquifers and clay lamination

# Attenuating:Archiving

The substrata as an archive of
technological intervention


Silt up of inundation canal bed with sediment
Compacting of Sediment around shape of previous inundation canal
Formation of kankar and calcification/ cementation under canal bed
Compacting of Sediment around shape of previous inundation canal
Decalcification of soil subject to frequent waterlogging
Decline in soil structure from intense agriculture
Compaction of sediment about location of former well

The gap between the abstracted models of the subsurface versus its true complexity has real impact on the landscape. The modelling of soil as having uniform attenuation of water led to problems with waterlogging, stagnant water, and disease [Ali, 1988, 220].

The consequences of reductionist models can be read from the traces that engineering intervention leave on the landscape. In this way the soils of the Punjab can be understood as an archive unto itself, where the geological substrate also serves as a textual substrate [Derrida, 1995] recording the historic rationalities it was subject to.

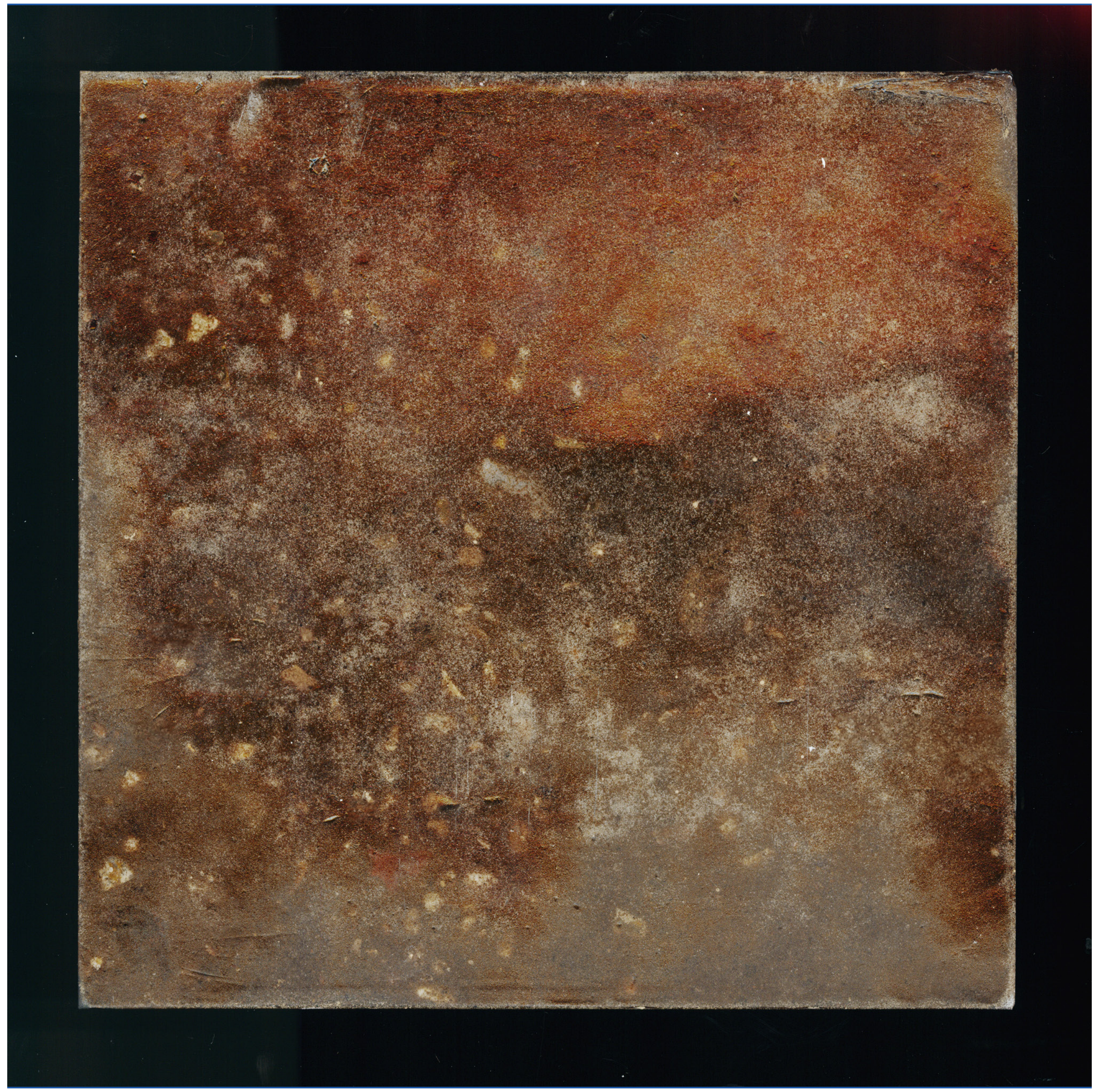
If the soil is an archive the Adjustable Proportional Module is a pivotal entry.
Part 1 showed how an instance of The Crump APM works within a nodal network but an APM is produced through a mobilisation of brick, cement and cast iron. It mobilises calcium deposits, limestone quarries, brickworks. Its design channels sediment and glacial water originating in the Himalayas to enter soil formed over millenia [Srivastava, 2015].

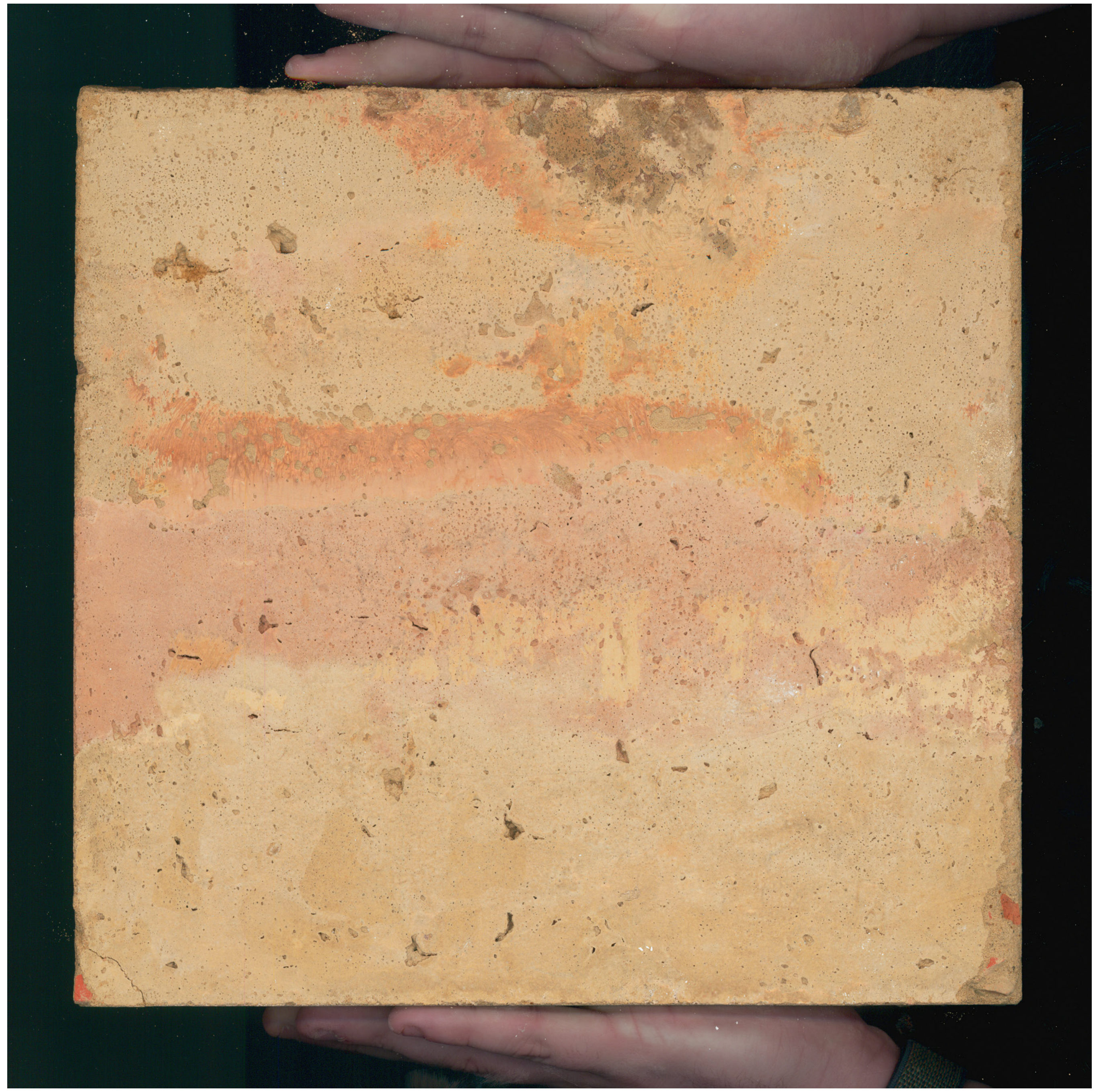
The supplied water attenuates through the soil into aquifers, their deposition recording the movement of river flows. By Witnessing these processes and being transformed by them [Targulian and Goryachkin, 2004, 2], the subsurface vertical serves as an archive.

In Derrida's 1995 Archive Fever (discussed in detail in part 4) he reflects on what a digital archive might look like, as both the material substrate of the conventional archive (paper, parchment) and the materiality of the archive itself (the building) become de-materialised as digital code, and therefore both the archive and that which is archived is merged.

Through the treatment of the subsurface as a series of datasets [Pereira, 2015, 2] the strata of the punjab can be seen as possessing the conditions of a digital archive, as the strata is both the text speaking to the processes it has witnessed while also being the substrate on which that text is recorded.

# Aquifer:Archive





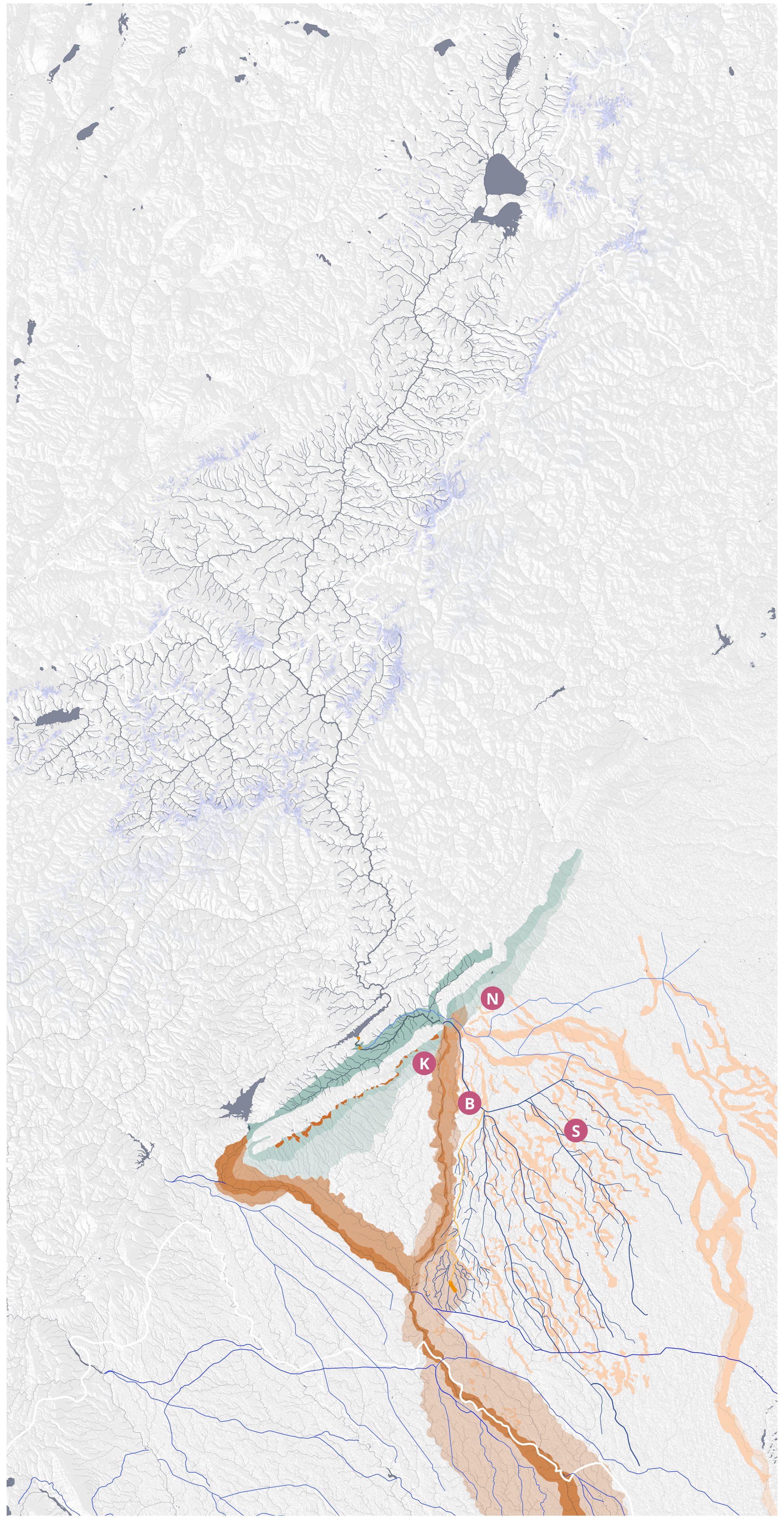
Model Scan of a 1:1 view of an Aquifer. Resin used to imitate how water fills the spaces between sand and sediment.

Model Scan of Concrete block made to Construction specifications of Sirhind Canal design

Flow:Attenuation

# Alluvial:Hydrological

Movement of matter by human
/ non-human forces



⊖ 100km

■ Sirhind Canal ■ Sirhind Canal,
Sidhwan Branch ■ 2L Minor
Distributary ■ Other Canals

■ Glacier Catchment① ■ Reservoir /
Waterbody② ■ River Course③ ■
Intermontane Deposit④ ■ Upper
Piedmont Deposit ■ Lower Piedmont
Deposit ■ Alluvial Fan Deposit ■ Active
Flood Plain ■ Dormant Flood Plain ■
Historic Flood Plain (Paleochannel)⑤

**Lake Rakshastal** River Sutlej Source

Glacial melt carries sediment to river

Sediment deposits form
**Piedmont plains**

**Nalagarh**
Limestone Mine

**Kerithpur**
Source for boulders

**Budki**
Source of Lime

Sediment dispersed across Punjab
Plains to form alluvial deposit

**Sirhind**
Aggregate from
palatial ruins

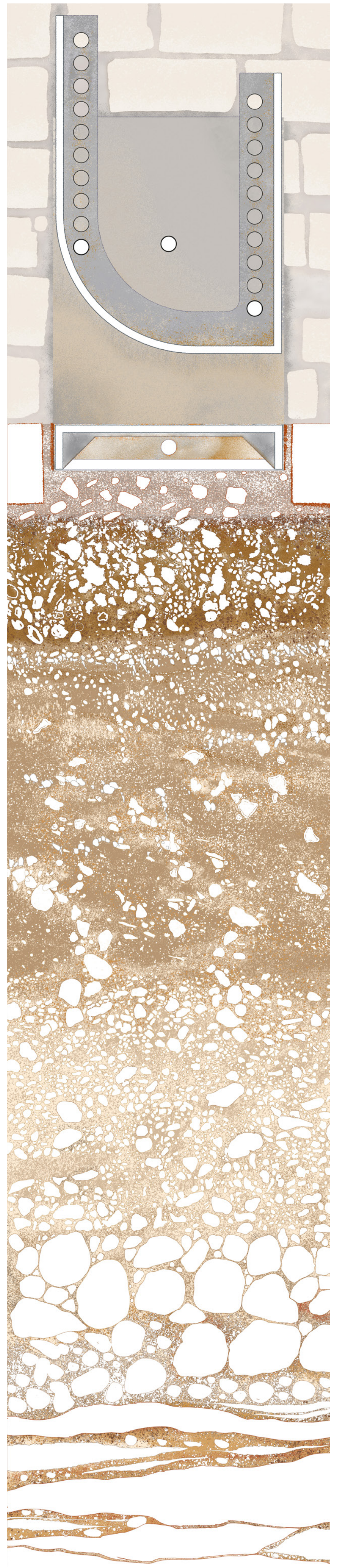
Alluvial Fan deposits form rivulets,
which aggrade to form **Paleochannels**

① GLIMS Dataset ② Hydrobase River Digitisation ③ Hydrobase River Digitisation compared against Landsat DEM ④ Bhatt, Litoria and Sharma, 2008 ⑤ Bhadra, 2022
All other features manually digitised with reference to satellite imagery and Survey of India mapping.

Cast Iron Mass-Produced Module Plates
Produced at Lahore Central Workshops pre-partition, Amritsar Workshops post-partition

Brick lining of flume

Mortar inset of Module base
Aggregate from the crushed brickwork of Sirhind Palace Ruins / Kunkur (Limestone) from Sutlej River banks at Budki



500mm

A Horizon
Typic Oxyaquic Haplustalfs, Sility Clay Loam, 200 um thick clay pedofeatures, Kankar Nodules.

Weak horizon formation

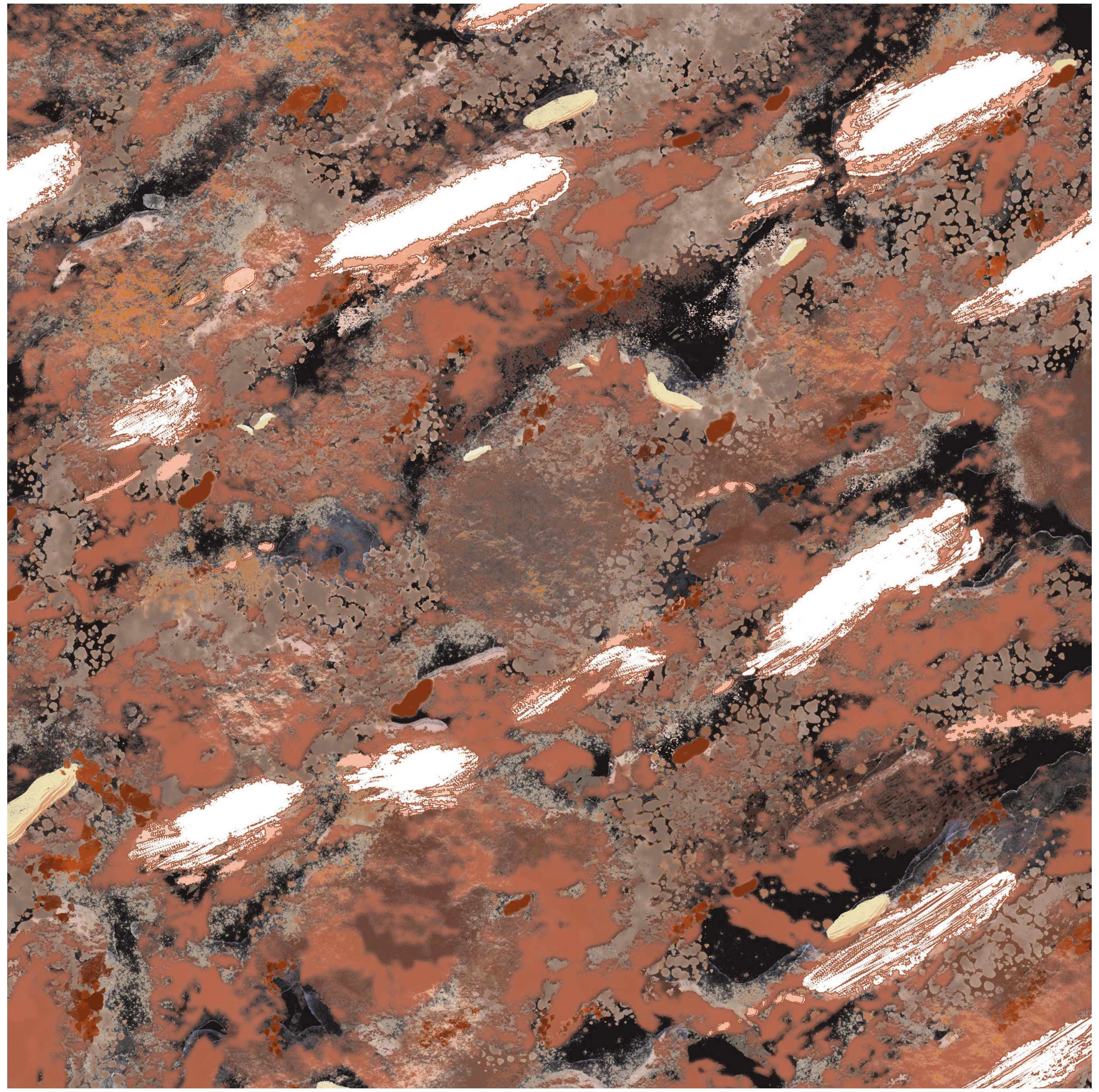
BW Horizon
Strong subangular blocky clay lattices, medium sand and sediument deposits with layers of fine sand.

BT Horizon
Sediment deposits with limited concretisation, mainly composed of fine to coarse grained sand. Interspersed with clay lamination and silt.

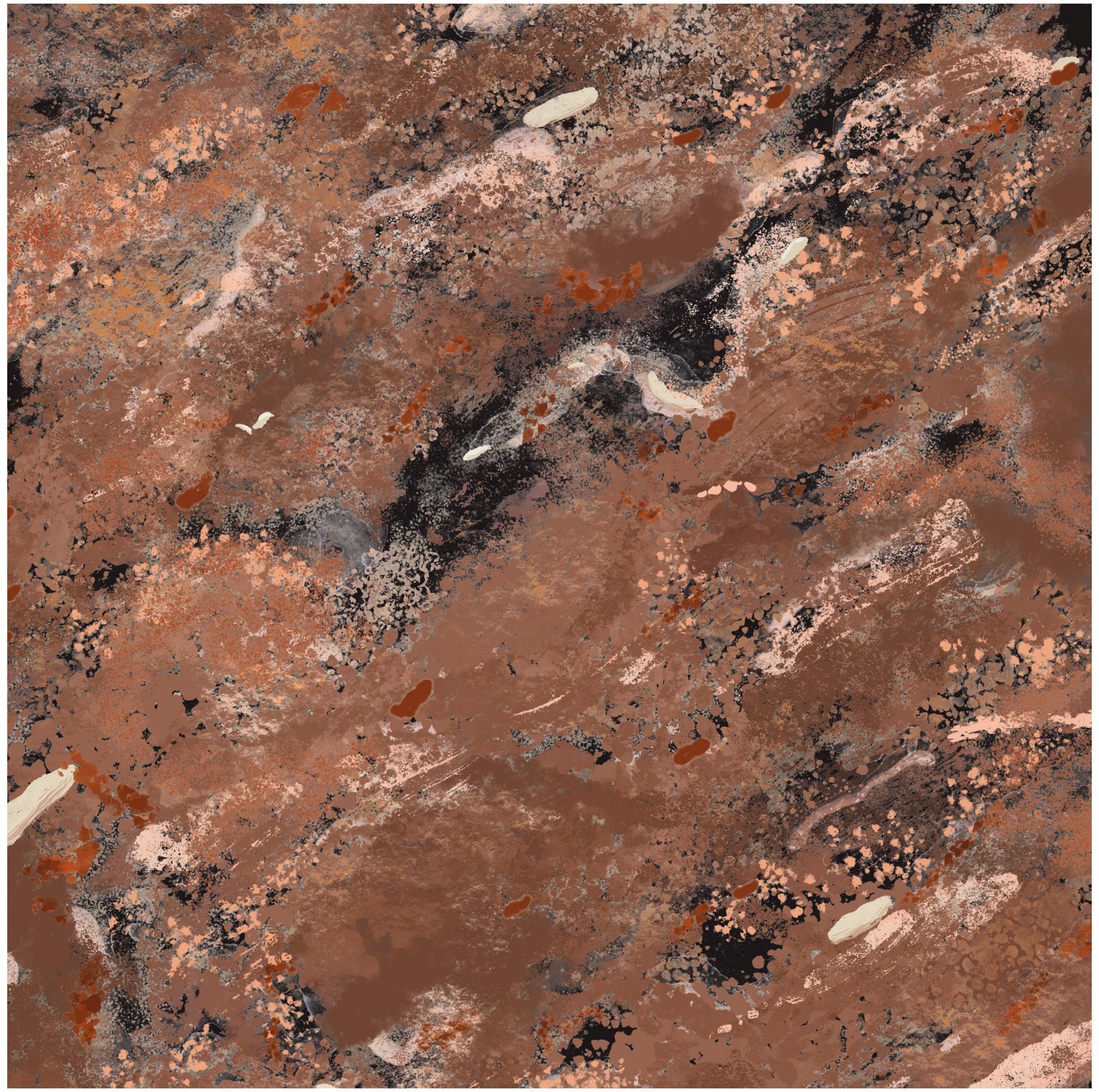
C Horizon
Clay Lenses beginning within the aquifer and producing aquitard layer. Compact bands of silt and kankar interspersed with some concretised sediment.

## Soil:Substrate

Soil's memory of axiomatic rationalities



Thin section through uncultivated alluvial soil. Strong form with clay latticing interspersed with Kankar and Myca deposits, developed from regular monsoonal flooding



Thin section through soil cultivated and watered with perennial canal irrigation. Regular waterlogging resulting in poor structure and decalcification

③

# Desiderata : Desedimentation

Image from MA1 EA Rs5 exhibition install showing
material sample studies and archival folios

# Introduction

*The functioning of a module is not to measure the quantity of water supplied, but to control it. It is therefore possible to charge a rate for the module based on the supply which it discharges, whether the full discharge be utilised or not. The cultivator can lessen the discharge from the module, or he can shut it off altogether; he cannot increase the discharge*

→ MacKenzie, 1910

*To be subject to seasonal rhythms was to be subject to fickle nature, and to be at the mercy of nature was to be primitive. Modernity announced itself by asserting the human capacity to tame and regulate nature. Perennial canals, British officials believed, would enable them to overcome the caprice of nature and allow them to reshape the land- scape as they wished. Inundation canals, on the other hand, embodied nature's constraints.*

→ Bhattacharya, 2021, 394

*But at the same time many engineers had forgotten the "design criteria"–as we now call them–which formed the basis for the planning and design. The whole process of design and operation had come to be based on empirical rules, standards and regulations, which were perfectly geared to the local social and economic circumstances–whatever these were at the time these rules had been established.*

→ Dahmen, 1997 via Ersten

I have shown how the design of canal infrastructure is formed through a stratification of ideals and objectives deposited by previous engineers, with contemporary political ideologies attenuating through this fragmented architecture that forms the engineering practice.

The standardised Crump Adjustable Proportional Outlet arose from this geneology of design While there is limited historical research into the design of canal outlets, their history can be read through the archival record of governmental policy, reports, and revenue audits.

Specifically, the outlet's design morphology is legible through engineering desiderata - lists of principles, ideals and targets that an outlet should fulfil. These principles were circulated among engineers in the Punjab Engineering Congress - a private organisation outside of the official structures of Public Works. In engaging with this strata of desiderata I have leant on Picon's formulation of 'The Engineer's Imagination' [Picon, 2004, 37] and its relationship to 'rationality' work to produce a historically-contingent idea of 'effectiveness' and 'effeciency'.

Contextualising this desiderata and their authors as historically produced actors is possible by reading through the Punjab Engineering Congress archive against the India Office Records, and with reference to the geologic reality that forms a "missing substrate" to the rationality espoused in these circles [Yusoff, 2017].

Understanding the premises on which the enduring infrastructural designs were based on allows helps demonstrate how and why contemporary environmental struggle has occured.

**Keywords**

→ Desiderata
Things Desired and Wanted, currently lacking. Used to outling the desires of engineers in the specification of outlets [Varma, 1917]

→ Rationality
As opposed to logic, rationality is historically contingent based on the imagination of the possible and desideratas at hand, and is therefore socially produced [Picon, 2004].

→ Imagination
After Picon [2004], Imagination seen as shaped by social and political factors, with the idea of what is "possible" as its horizon

→ Regime
Under Kennedy's 1895 formula regime is where the flow of water through a canal is stable. The design of the outlet is to determine the success / failure of a canal's regime [Varma, 1917].

# Timeline

①⑧⑧③ **Irrigation begins on the Sirhind Canal**
Temporary Canal Outlets Adopted along Sirhind Canal

Initially, All Outlets were provided Flap valves so as to...
*"...So that the trouble of making a bund or otherwise closing the outlet may be avoided, and in this they greatly contribute to economy of water."*
[Mahbub & Gulhati, 1944]

①⑧⑨③ **Silt Up of the Sirhind Canal**
Call for Papers on Outlets from Superintending Engineers

①⑧⑨⑤ **Kennedy's Formula**

①⑧⑨⑥ **Summary of Superindendent findings from Chief Engineer**

①⑨⓪② **Kennedy's Cill Outlet**

①⑨⓪⑥ **Kennedy's desiderata for outlet design**
Kennedy's Guage Outlet

Beginning of a series of setting out criteria for other engineers to follow

①⑨⓪⑧ **Beresford's Masonry Outlet**

①⑨⓪⑧ **Gibb's Module**

Limited impact of these outlets;
*"The Kennedy gauge outlet and the Gibb module remained in an experimental stage and were being perfected by their inventors in this period. The general form of outlets in use in the Punjab Irrigation, right up to 1920, was, however, the pipe or barrel outlet."*
[Mahbub & Gulhati, 1944]

①⑨①⓪ **Gordon's Outlet Desiderata**

①⑨①① **Benton's Outlet Desiderata**

①⑨①② **Punjab Engineering Congress Founded**

①⑨①② **Colyer submits paper calling for irrigation research centre**

①⑨①⑥ **Harvey Stoddard Outlet**

①⑨②② **Crump Publishes Moduling of Irrigation Channels**
Introducing the Adjustable Proportional Module (APM)

①⑨②④ **Public Works Department recommend use of APM**

①⑨②⑤ **Crump De-Gruyter Structure Developed**

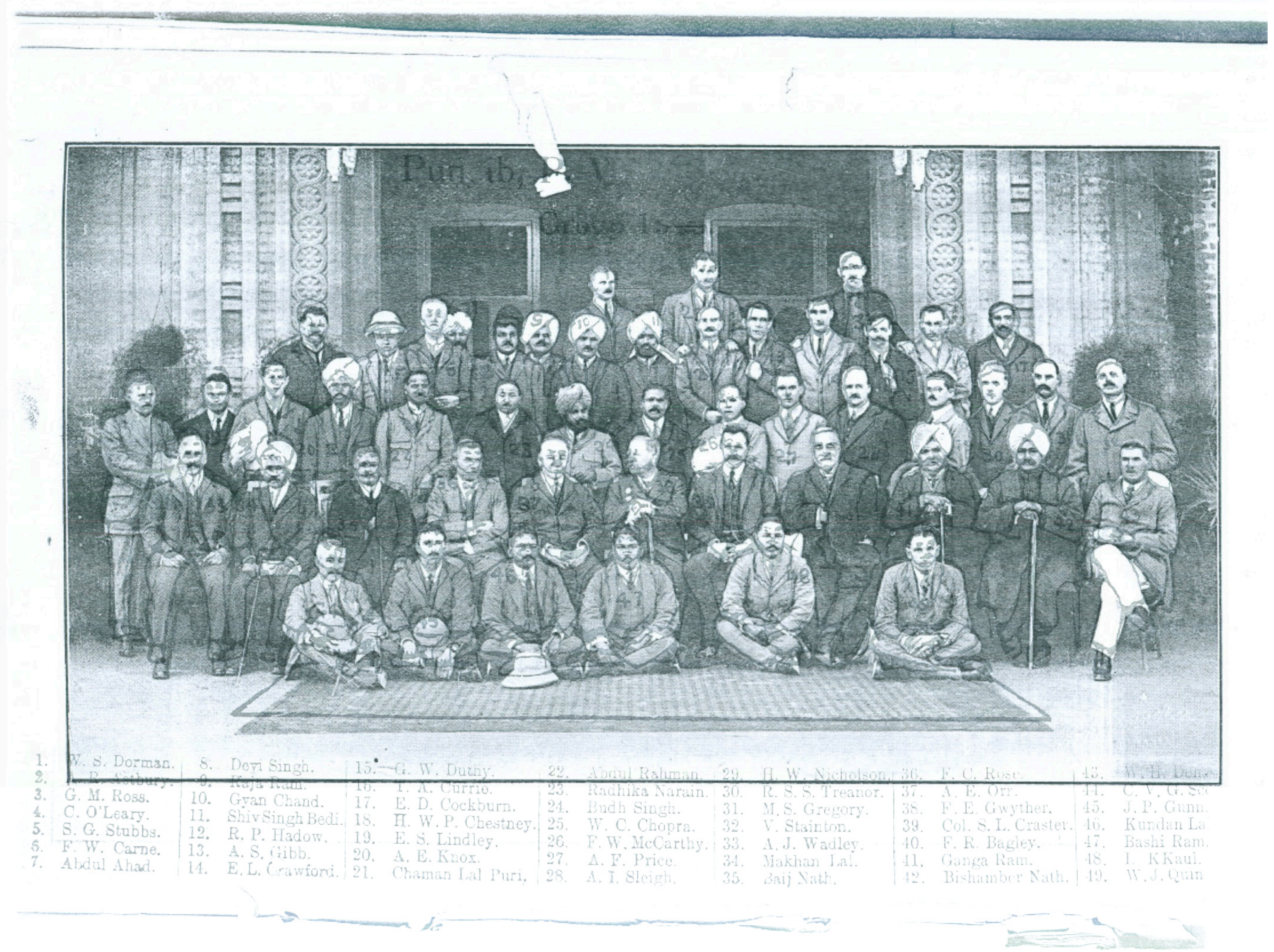
①⑨③④ **Lacey's Slope Formula Formally Adopted by Central Board of Irrigation Research**

By the beginning of 1924, orders had been issued that
*"the A.P.Ms or where more suitable the O.F. type of outlet-- should be generally adopted in future remodelling. It was left to the option of the local officers either to indent on the Central Workshops for cast iron orifices or to arrange for these to be made locally at a small cost."*
[Mahbub & Gulhati, 1944]

①⑨③⑤ **Remodelling of Canals to incorporate Crump's APM**

①⑨④④ **67% of all Outlets are APMs across then-united Punjab**

①⑨⑦⑥ **Crump APM Standardised as IS:9786**



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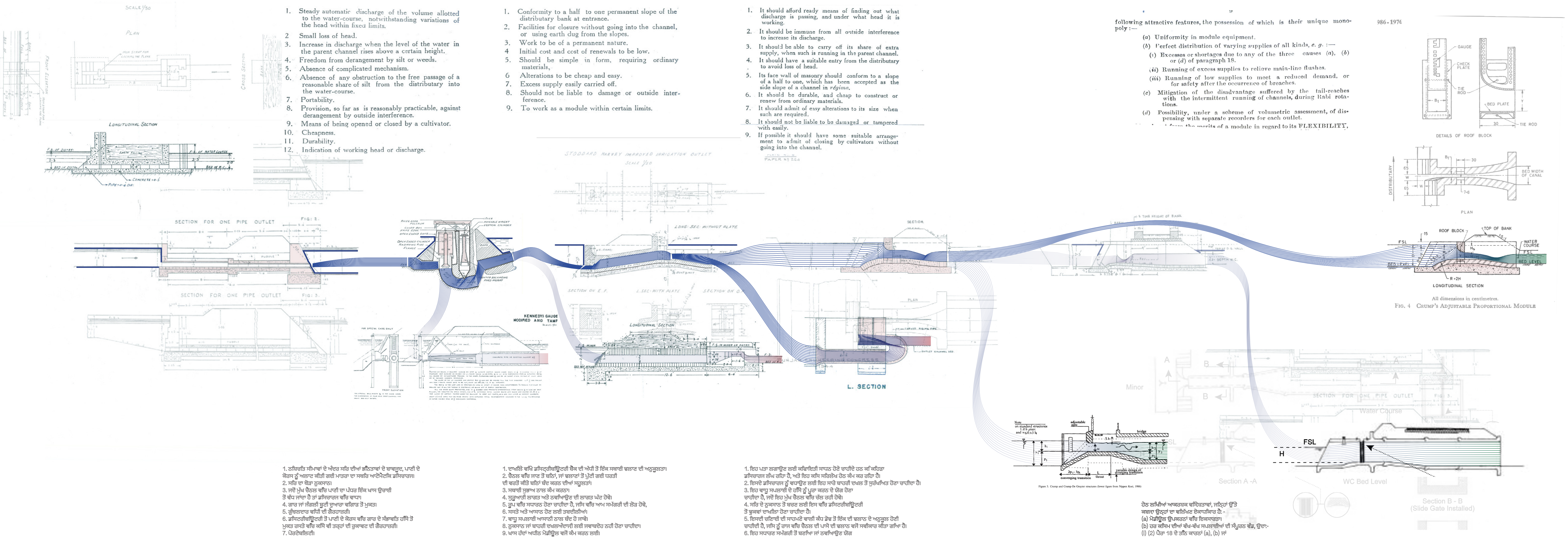
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | W. S. Dorman. | 8. | Devi Singh. | 15. | G. W. Duthy. | 22. | Abdul Rahman. | 29. | H. W. Nicholson. | 36. | F. C. Rose. | 43. | W. H. Dun |
| 2. | R. Astbury. | 9. | Raja Ram. | 16. | T. A. Currie. | 23. | Radhika Narain. | 30. | R. S. S. Treanor. | 37. | A. E. Orr. | 44. | C. V. G. Sc |
| 3. | G. M. Ross. | 10. | Gyan Chand. | 17. | E. D. Cockburn. | 24. | Budh Singh. | 31. | M. S. Gregory. | 38. | F. E. Gwyther. | 45. | J. P. Gunn. |
| 4. | C. O'Leary. | 11. | Shiv Singh Bedi. | 18. | H. W. P. Chestney. | 25. | W. C. Chopra. | 32. | V. Stainton. | 39. | Col. S. L. Craster. | 46. | Kundan La |
| 5. | S. G. Stubbs. | 12. | R. P. Hadow. | 19. | E. S. Lindley. | 26. | F. W. McCarthy. | 33. | A. J. Wadley. | 40. | F. R. Bagley. | 47. | Bashi Ram. |
| 6. | F. W. Carne. | 13. | A. S. Gibb. | 20. | A. E. Knox. | 27. | A. F. Price. | 34. | Makhan Lal. | 41. | Ganga Ram. | 48. | I. K Kaul. |
| 7. | Abdul Ahad. | 14. | E. L. Crawford. | 21. | Chaman Lal Puri. | 28. | A. I. Sleigh. | 35. | Baij Nath. | 42. | Bishamber Nath. | 49. | W. J. Quin |

# Desiderata:Modular

Progression of outlet design through engineering circles


SCALE 1/30
PLAN
FRONT ELEVATION
CROSS SECTION
BANK
LONGITUDINAL SECTION
F.S. OF DISTY.
F.S. OF WATERCOURSE
EARTH FILLING
CONCRETE 1:4:6
PIPE 6" DIA.
SECTION FOR ONE PIPE OUTLET
FIG: 2
SECTION FOR ONE PIPE OUTLET
FIG: 3
KENNEDY'S GAUGE MODIFIED AND TAMP
STODDARD HARVEY IMPROVED IRRIGATION OUTLET
SCALE 1/20
LONG: SEC. WITHOUT PLATE
SECTION ON E.F.
L. SEC. WITH PLATE
LONGITUDINAL SECTION
PLATE No. 8
PAPER No 264
L. SECTION
SECTION
PLAN
WATER COURSE
DETAILS OF ROOF BLOCK
GAUGE
CHECK PLATE
TIE ROD
BED PLATE
DISTRIBUTARY
BED WIDTH OF CANAL
ROOF BLOCK
TOP OF BANK
FSL
WATER COURSE
BED LEVEL
LONGITUDINAL SECTION
converging transition
throat
variable design of diverging transition
Minor
Water Course
Section A -A
WC Bed Level
Section B - B
(Slide Gate Installed)
FSL
H
986-1976

1. Steady automatic discharge of the volume allotted to the water-course, notwithstanding variations of the head within fixed limits.
2. Small loss of head.
3. Increase in discharge when the level of the water in the parent channel rises above a certain height.
4. Freedom from derangement by silt or weeds.
5. Absence of complicated mechanism.
6. Absence of any obstruction to the free passage of a reasonable share of silt from the distributary into the water-course.
7. Portability.
8. Provision, so far as is reasonably practicable, against derangement by outside interference.
9. Means of being opened or closed by a cultivator.
10. Cheapness.
11. Durability.
12. Indication of working head or discharge.

1. Conformity to a half to one permanent slope of the distributary bank at entrance.
2. Facilities for closure without going into the channel, or using earth dug from the slopes.
3. Work to be of a permanent nature.
4. Initial cost and cost of renewals to be low.
5. Should be simple in form, requiring ordinary materials,
6. Alterations to be cheap and easy.
7. Excess supply easily carried off.
8. Should not be liable to damage or outside interference.
9. To work as a module within certain limits.

1. It should afford ready means of finding out what discharge is passing, and under what head it is working.
2. It should be immune from all outside interference to increase its discharge.
3. It should be able to carry off its share of extra supply, when such is running in the parent channel.
4. It should have a suitable entry from the distributary to avoid loss of head.
5. Its face wall of masonry should conform to a slope of a half to one, which has been accepted as the side slope of a channel in *régime*.
6. It should be durable, and cheap to construct or renew from ordinary materials.
7. It should admit of easy alterations to its size when such are required.
8. It should not be liable to be damaged or tampered with easily.
9. If possible it should have some suitable arrangement to admit of closing by cultivators without going into the channel.

following attractive features, the possession of which is their unique monopoly :—

(*a*) Uniformity in module equipment.
(*b*) Perfect distribution of varying supplies of all kinds, *e. g.* :—
  (*i*) Excesses or shortages due to any of the three causes (*a*), (*b*) or (*d*) of paragraph 18.
  (*ii*) Running of excess supplies to relieve main-line flushes.
  (*iii*) Running of low supplies to meet a reduced demand, or for safety after the occurrence of breaches.
(*c*) Mitigation of the disadvantage suffered by the tail-reaches with the intermittent running of channels, during Rabi rotations.
(*d*) Possibility, under a scheme of volumetric assessment, of dispensing with separate recorders for each outlet.

… from the merits of a module in regard to its FLEXIBILITY,

All dimensions in centimetres.

FIG. 4 CRUMP'S ADJUSTABLE PROPORTIONAL MODULE

Figure 3. Crump and Crump-De Gruyter structures (lower figure from Nippen Koei, 1986)

1. ਨਸ਼ਿਚਤਿ ਸੀਮਾਵਾਂ ਦੇ ਅੰਦਰ ਸਰਿ ਦੀਆਂ ਭੰਨਿਤਾਵਾਂ ਦੇ ਬਾਵਜੂਦ, ਪਾਣੀ ਦੇ
ਕੋਰਸ ਨੂੰ ਅਲਾਟ ਕੀਤੀ ਗਈ ਮਾਤਰਾ ਦਾ ਸਥਰਿ ਆਟੋਮੈਟਕਿ ਡਸਿਚਾਰਜ।
2. ਸਰਿ ਦਾ ਥੋੜ੍ਹਾ ਨੁਕਸਾਨ।
3. ਜਦੋਂ ਮੁੱਖ ਚੈਨਲ ਵੱਿਚ ਪਾਣੀ ਦਾ ਪੱਧਰ ਇੱਕ ਖਾਸ ਉਚਾਈ
ਤੋਂ ਵੱਧ ਜਾਂਦਾ ਹੈ ਤਾਂ ਡਸਿਚਾਰਜ ਵੱਿਚ ਵਾਧਾ।
4. ਗਾਰ ਜਾਂ ਜੰਗਲੀ ਬੂਟੀ ਦੁਆਰਾ ਵਗਿਾੜ ਤੋਂ ਮੁਕਤ।
5. ਗੁੰਝਲਦਾਰ ਵਧਿੀ ਦੀ ਗੈਰਹਾਜ਼ਰੀ।
6. ਡਸਿਟਰੀਬਊਿਟਰੀ ਤੋਂ ਪਾਣੀ ਦੇ ਕੋਰਸ ਵੱਿਚ ਗਾਰ ਦੇ ਸੰਭਾਵਤਿ ਹੱਸਿੇ ਤੋਂ
ਮੁਕਤ ਰਸਤੇ ਵੱਿਚ ਕਸਿੇ ਵੀ ਤਰ੍ਹਾਂ ਦੀ ਰੁਕਾਵਟ ਦੀ ਗੈਰਹਾਜ਼ਰੀ।
7. ਪੋਰਟੇਬਲਿਟੀ।
8. ਬਾਹਰੀ ਦਖਲਅੰਦਾਜ਼ੀ ਦੁਆਰਾ ਵਗਿਾੜ ਤੋਂ ਸੁਰੱਖਆਿਤ, ਜੱਥਿੇ ਤੱਕ ਵਾਜਬ ਤੌਰ 'ਤੇ ਵਹਿਾਰਕ ਹੋਵੇ।
9. ਕਾਸ਼ਤਕਾਰ ਦੁਆਰਾ ਖੋਲ੍ਹੇ ਜਾਂ ਬੰਦ ਕੀਤੇ ਜਾਣ ਦੇ ਯੋਗ।
10. ਸਸਤਾ।
11. ਟਕਿਾਊ।
12. ਕਾਰਜ ਸਰਿਲੇਖ ਜਾਂ ਡਸਿਚਾਰਜ ਦਾ ਸੰਕੇਤ।

1. ਦਾਖਲਿੇ ਵਖਿੇ ਡਸਿਟ੍ਰੀਬਊਿਟਰੀ ਬੈਂਕ ਦੀ ਅੱਧੀ ਤੋਂ ਇੱਕ ਸਥਾਈ ਢਲਾਣ ਦੀ ਅਨੁਕੂਲਤਾ।
2. ਚੈਨਲ ਵੱਿਚ ਜਾਣ ਤੋਂ ਬਨਿਾਂ, ਜਾਂ ਢਲਾਣਾਂ ਤੋਂ ਪੁੱਟੀ ਗਈ ਧਰਤੀ
ਦੀ ਵਰਤੋਂ ਕੀਤੇ ਬਨਿਾਂ ਬੰਦ ਕਰਨ ਦੀਆਂ ਸਹੂਲਤਾਂ।
3. ਸਥਾਈ ਸੁਭਾਅ ਨਾਲ ਕੰਮ ਕਰਨਾ।
4. ਸ਼ੁਰੂਆਤੀ ਲਾਗਤ ਅਤੇ ਨਵਆਿਉਣ ਦੀ ਲਾਗਤ ਘੱਟ ਹੋਵੇ।
5. ਰੂਪ ਵੱਿਚ ਸਧਾਰਨ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ, ਜਸਿ ਵੱਿਚ ਆਮ ਸਮੱਗਰੀ ਦੀ ਲੋੜ ਹੋਵੇ,
6. ਸਸਤੇ ਅਤੇ ਆਸਾਨ ਹੋਣ ਲਈ ਤਬਦੀਲੀਆਂ।
7. ਵਾਧੂ ਸਪਲਾਈ ਆਸਾਨੀ ਨਾਲ ਬੰਦ ਹੋ ਜਾਵੇ।
8. ਨੁਕਸਾਨ ਜਾਂ ਬਾਹਰੀ ਦਖਲਅੰਦਾਜ਼ੀ ਲਈ ਜਵਾਬਦੇਹ ਨਹੀਂ ਹੋਣਾ ਚਾਹੀਦਾ।
9. ਖਾਸ ਹੱਦਾਂ ਅਧੀਨ ਮੋਡੀਊਲ ਵਜੋਂ ਕੰਮ ਕਰਨ ਲਈ।

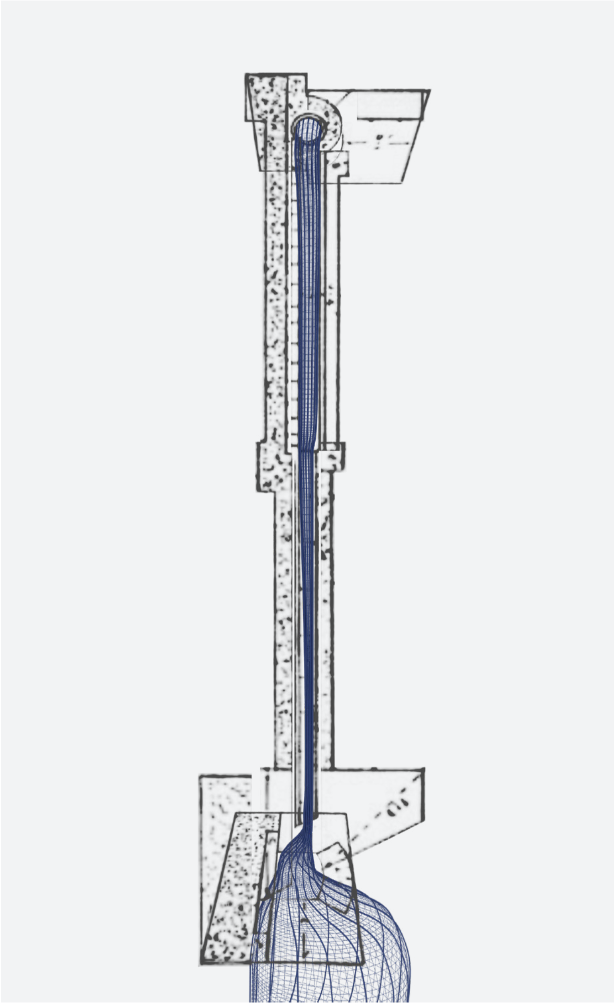
1. ਇਹ ਪਤਾ ਲਗਾਉਣ ਲਈ ਕਫਿਾਇਤੀ ਸਾਧਨ ਹੋਣੇ ਚਾਹੀਦੇ ਹਨ ਕ ਿਕਹਿੜਾ
ਡਸਿਚਾਰਜ ਲੰਘ ਰਹਿਾ ਹੈ, ਅਤੇ ਇਹ ਕਸਿ ਸਰਿਲੇਖ ਹੇਠ ਕੰਮ ਕਰ ਰਹਿਾ ਹੈ।
2. ਇਸਦੇ ਡਸਿਚਾਰਜ ਨੂੰ ਵਧਾਉਣ ਲਈ ਇਹ ਸਾਰੇ ਬਾਹਰੀ ਦਖਲ ਤੋਂ ਸੁਰੱਖਆਿਤ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ।
3. ਇਹ ਵਾਧੂ ਸਪਲਾਈ ਦੇ ਹੱਸਿੇ ਨੂੰ ਪੂਰਾ ਕਰਨ ਦੇ ਯੋਗ ਹੋਣਾ
ਚਾਹੀਦਾ ਹੈ, ਜਦੋਂ ਇਹ ਮੁੱਖ ਚੈਨਲ ਵੱਿਚ ਚੱਲ ਰਹੀ ਹੋਵੇ।
4. ਸਰਿ ਦੇ ਨੁਕਸਾਨ ਤੋਂ ਬਚਣ ਲਈ ਇਸ ਵੱਿਚ ਡਸਿਟਰੀਬਊਿਟਰੀ
ਤੋਂ ਢੁਕਵਾਂ ਦਾਖਲਾ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ।
5. ਇਸਦੀ ਚਣਿਾਈ ਦੀ ਸਾਹਮਣੇ ਵਾਲੀ ਕੰਧ ਡੇਢ ਤੋਂ ਇੱਕ ਦੀ ਢਲਾਨ ਦੇ ਅਨੁਕੂਲ ਹੋਣੀ
ਚਾਹੀਦੀ ਹੈ, ਜਸਿ ਨੂੰ ਰਾਜ ਵੱਿਚ ਚੈਨਲ ਦੀ ਪਾਸੇ ਦੀ ਢਲਾਨ ਵਜੋਂ ਸਵੀਕਾਰ ਕੀਤਾ ਗਆਿ ਹੈ।
6. ਇਹ ਸਧਾਰਣ ਸਮੱਗਰੀ ਤੋਂ ਬਣਆਿ ਜਾਂ ਨਵਆਿਉਣ ਯੋਗ
ਟਕਿਾਊ, ਅਤੇ ਸਸਤਾ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ।
7. ਜਦੋਂ ਲੋੜ ਹੋਵੇ ਤਾਂ ਇਹ ਆਪਣੇ ਆਕਾਰ ਵੱਿਚ ਆਸਾਨ
ਤਬਦੀਲੀਆਂ ਨੂੰ ਸਵੀਕਾਰ ਕਰਨ ਦੇ ਯੋਗ ਹੋਵੇ।
8. ਇਸਨੂੰ ਆਸਾਨੀ ਨਾਲ ਨੁਕਸਾਨ ਪਹੁੰਚਾਉਣ ਜਾਂ ਇਸ ਨਾਲ
ਛੇੜਛਾੜ ਕਰਨ ਲਈ ਜ਼ਮਿੇਵਾਰ ਨਹੀਂ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ।
9. ਜੇਕਰ ਸੰਭਵ ਹੋਵੇ ਤਾਂ ਇਸ ਵੱਿਚ ਚੈਨਲ ਵੱਿਚ ਗਏ ਬਨਿਾਂ ਕਾਸ਼ਤਕਾਰਾਂ ਦੁਆਰਾ
ਬੰਦ ਕਰਨ ਦੀ ਸਵੀਕ੍ਰਤੀ ਲਈ ਕੁਝ ਢੁਕਵਾਂ ਪ੍ਰਬੰਧ ਹੋਣਾ ਚਾਹੀਦਾ ਹੈ।

ਹੇਠ ਲਖਿੀਆਂ ਆਕਰਸ਼ਕ ਵਸ਼ਿੇਸ਼ਤਾਵਾਂ, ਜਨ੍ਹਿਾਂ ਉੱਤੇ
ਕਬਜ਼ਾ ਉਨ੍ਹਾਂ ਦਾ ਵਲਿੱਖਣ ਏਕਾਧਕਿਾਰ ਹੈ: -
(a) ਮੋਡੀਊਲ ਉਪਕਰਨਾਂ ਵੱਿਚ ਇਕਸਾਰਤਾ।
(b) ਹਰ ਕਸਿਮ ਦੀਆਂ ਵੱਖ-ਵੱਖ ਸਪਲਾਈਆਂ ਦੀ ਸੰਪੂਰਨ ਵੰਡ, ਉਦਾ:-
(i) (2) ਪੈਰਾ 18 ਦੇ ਤੀਨ ਕਾਰਨਾਂ (a), (b) ਜਾਂ
(d) ਵੱਿਚੋਂ ਕਸਿੇ ਕਾਰਨ ਵਾਧੇ ਜਾਂ ਘਾਟੇ।
(ii) ਮੁੱਖ-ਲਾਈਨ ਫਲੱਸ਼ਾਂ ਤੋਂ ਰਾਹਤ ਪਾਉਣ
ਲਈ ਵਾਧੂ ਸਪਲਾਈਆਂ ਨੂੰ ਚਲਾਉਣਾ।
(iii) ਘੱਟ ਹੋਈ ਮੰਗ ਨੂੰ ਪੂਰਾ ਕਰਨ ਲਈ, ਜਾਂ ਰਸਿਾਅ ਦੇ ਵਾਪਰਨ
ਤੋਂ ਬਾਅਦ ਸੁਰੱਖਆਿ ਲਈ ਘੱਟ ਸਪਲਾਈ ਦਾ ਚੱਲਣਾ।
(c) ਰੱਬੀ ਰੋਟੇਸ਼ਨ ਦੌਰਾਨ, ਚੈਨਲਾਂ ਦੇ ਰੁਕ-ਰੁਕ ਕੇ ਚੱਲਣ ਸਮੇਤ,
ਟੇਲ-ਪਹੁੰਚ ਦੁਆਰਾ ਸਹਣਿ ਕੀਤੇ ਨੁਕਸਾਨ ਦੀ ਭਰਪਾਈ।

Punjabi (Gurmukhi script) professionally
translated by Navpreet Singh

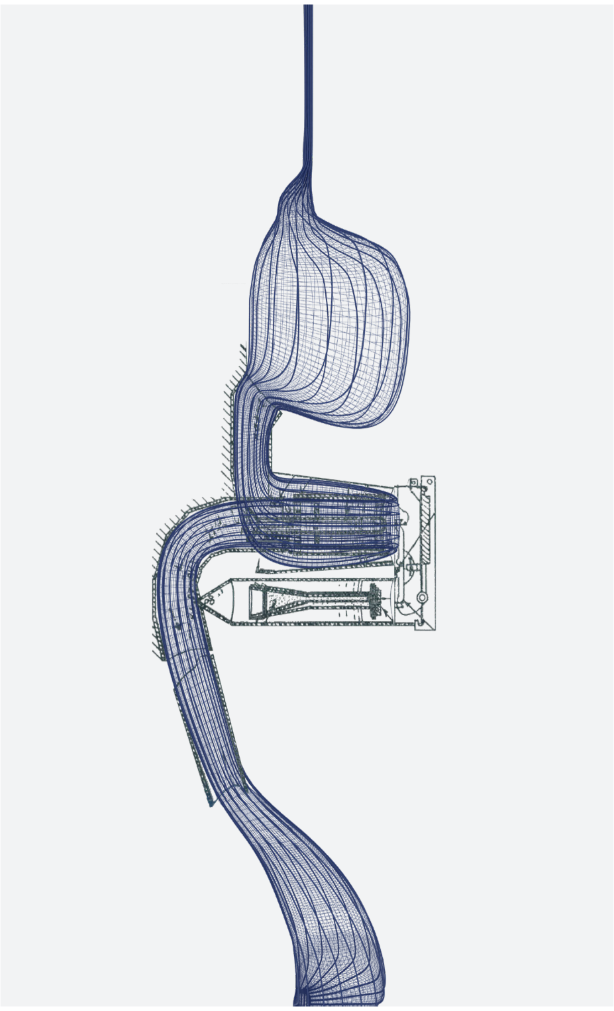
# Desiderata:Modular

Core Outlets in focus



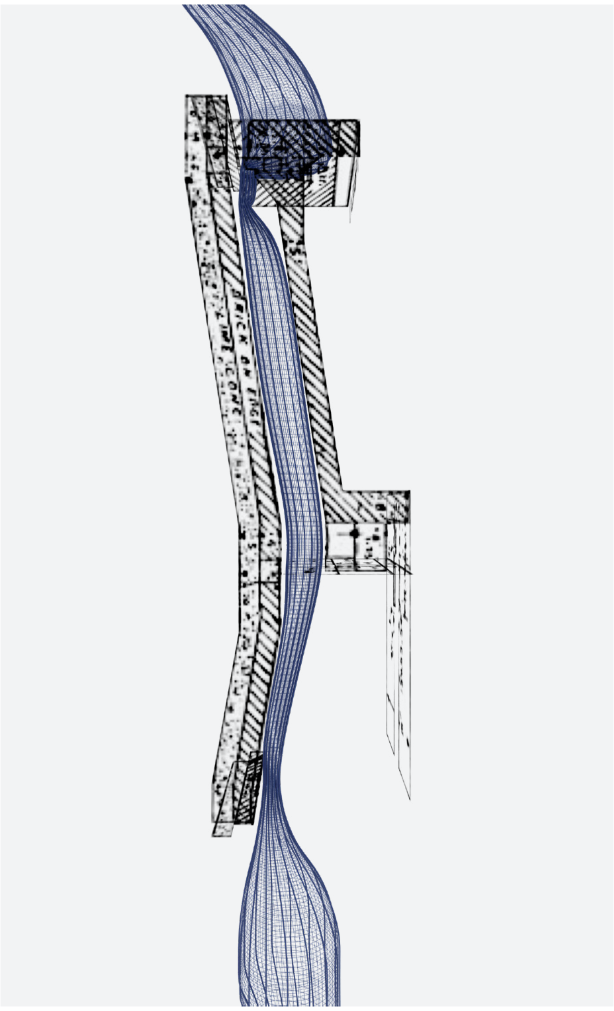
**1883 - Pipe Outlets**

Early Perenial Canal construction used pipe outlets with gates to open and close [Varma, 1917, 102] After several incidents of silt build-up blocking the canals' water flow [ibid, 113], Kennedy's Silt Theory [Kennedy, 1895] held that a canal will be in "Regime" relative to the velocity of the water and the silt content carried.



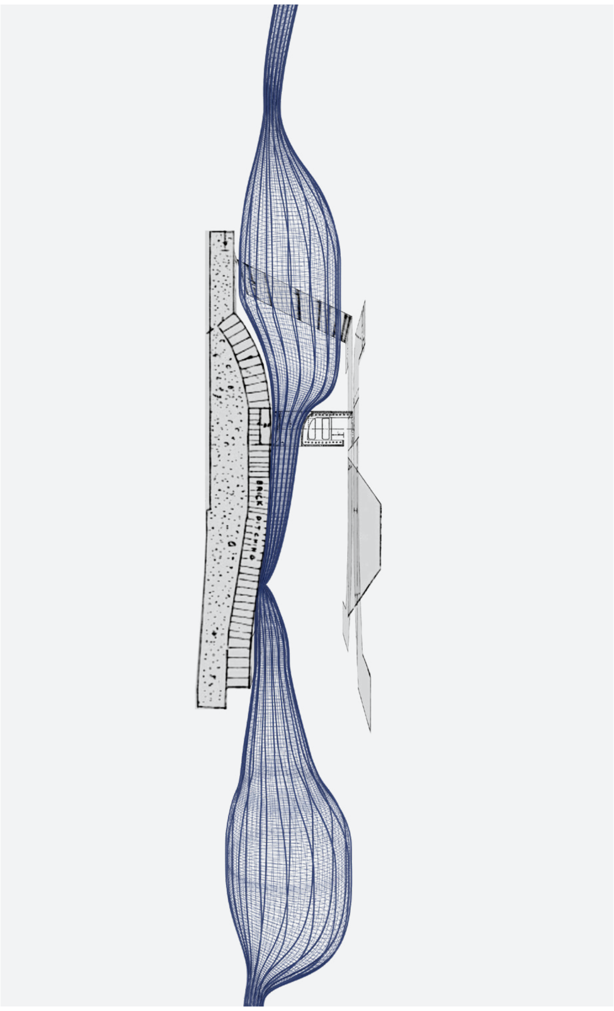
**1902 - Kennedy Outlet**

Kennedy's outlet attempted to apply this rationalised formulation of water distribution, also seeking to minimise the agency of farmers over their water access.



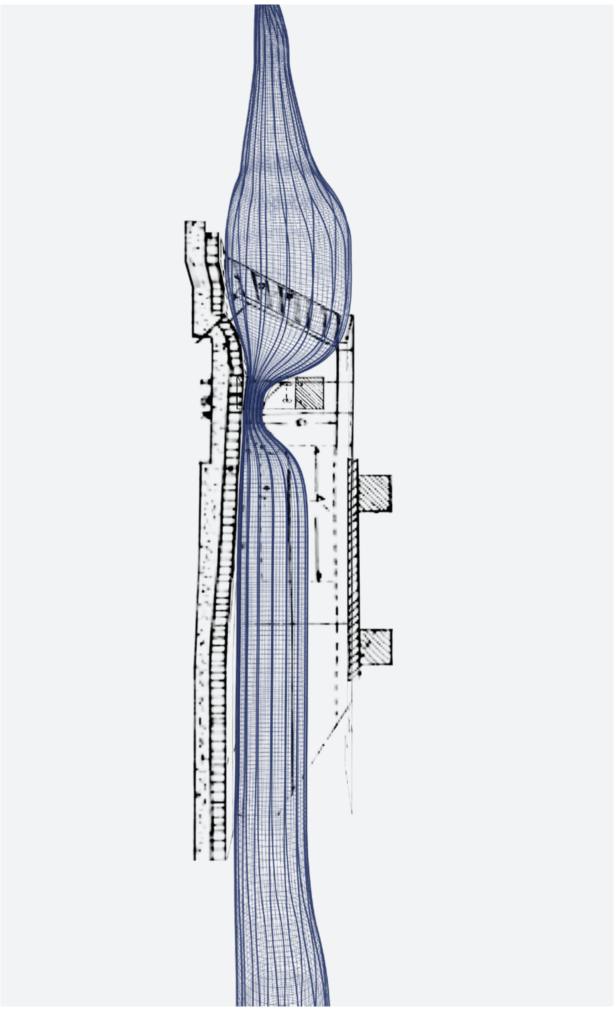
**1916 - Harvey Stoddard Outlet**

Kennedy's formula was carried through in varying outlet designs, although his outlet was deemed too complicated. The Harvey Stoddard Outlet thus sought to maintain silt intake and water flow while also having flexibility.



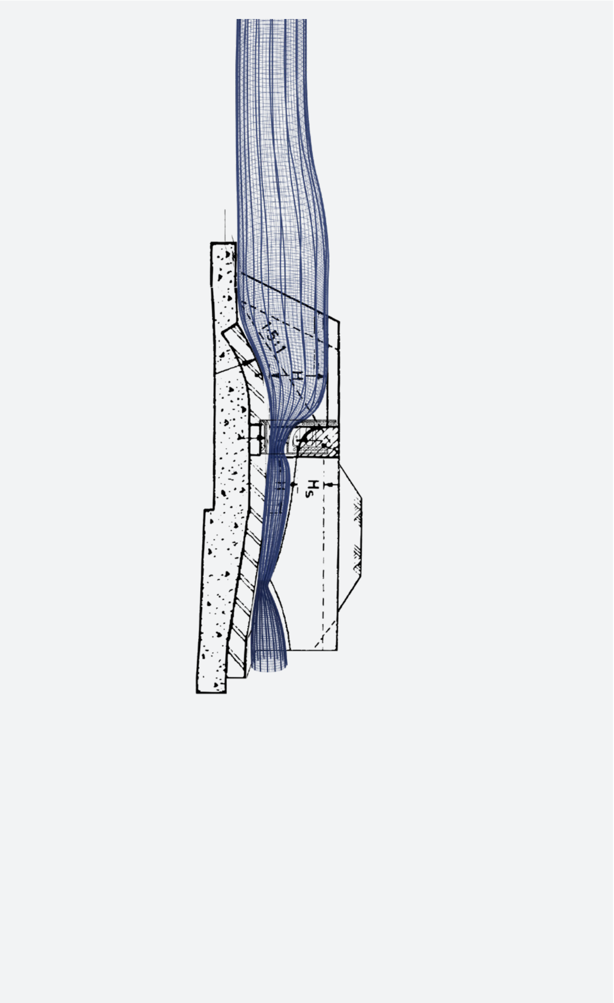
**1922 Crump Adjustable Proportional Module**

The Crump Adjustable Proportional Module adhered to Kennedy's formula while also seeking to provide flexibility. Its cast iron inset allowed for a mass production and mass deployment of its rationale. Being set in cement it also prevented users from being able to alter the water supply.



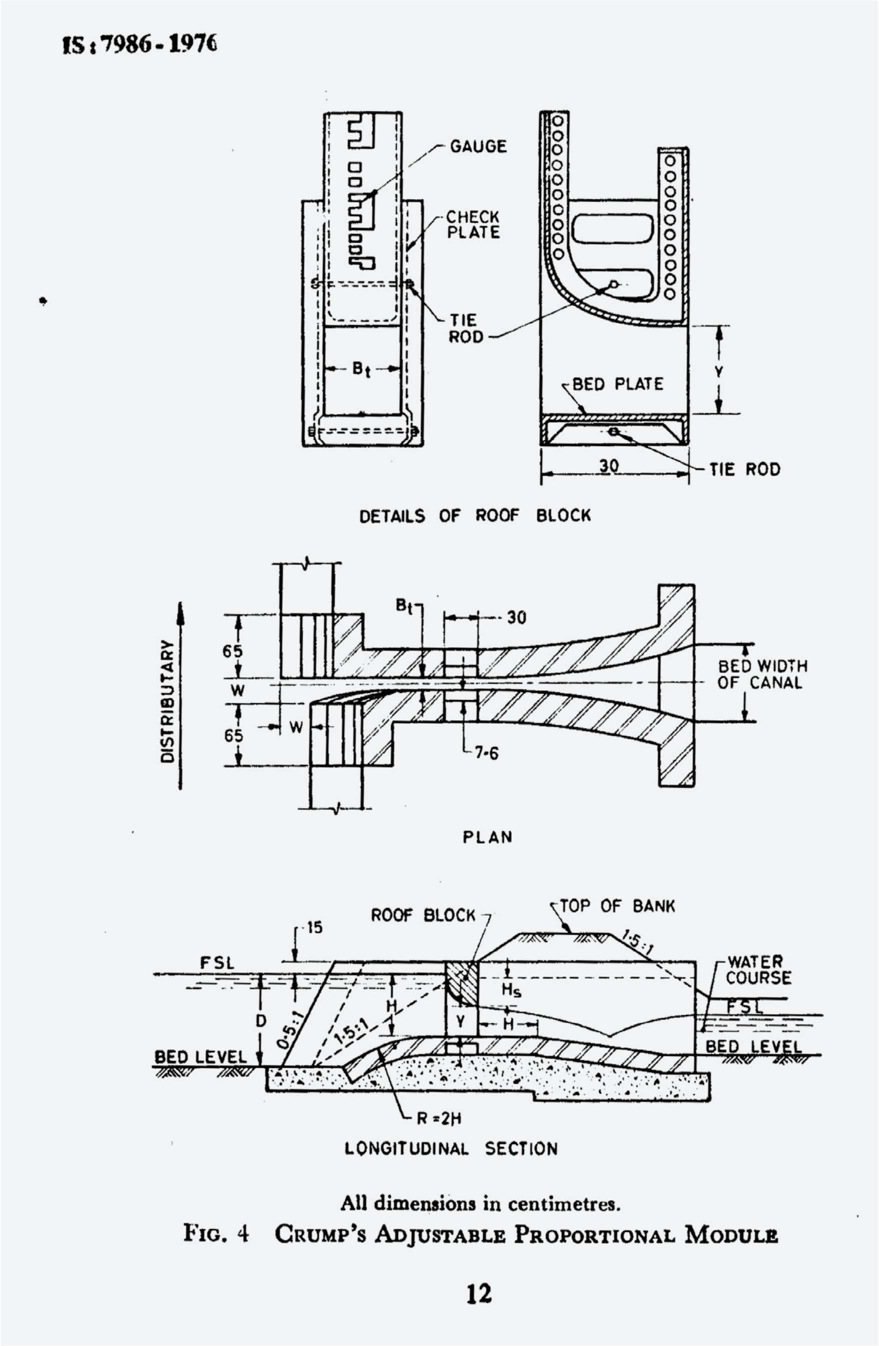
**1940 Sharma's 'Improved' APM**

In 1934 the Lacey Slope Formula was endorsed by the Public Works Department [Blench, 1935]. Sharma's 1940 Design sought to "improve" the Crump design to incorporate findings from new formulae and practical experiments [Sharma, 1940].



**1976 - IS Standard 7986**

By 1944, 67% of all outlets in the Punjab were Crump APMs [Van Halsema, 2002, 50]. Despite Sharma's critique, the original design of the APM as set out by ES Crump in 1922 became the IS Standard in 1976 [IS:7986, 1976].



IS : 7986 - 1976

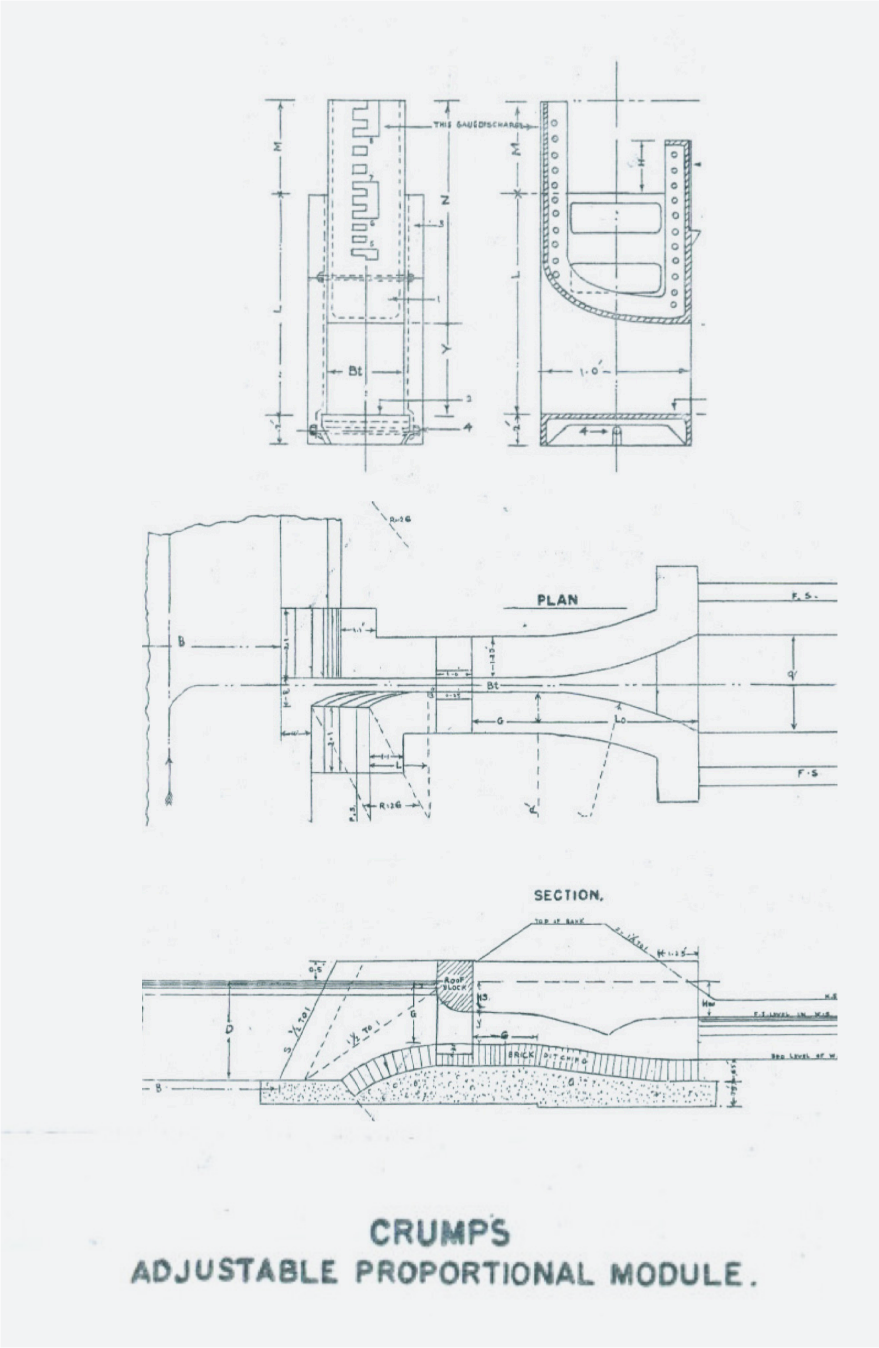
GAUGE
CHECK PLATE
TIE ROD
$B_t$
Y
BED PLATE
30
TIE ROD
DETAILS OF ROOF BLOCK
DISTRIBUTARY
$B_t$
30
65
W
65
W
7·6
BED WIDTH OF CANAL
PLAN
ROOF BLOCK
TOP OF BANK
15
1·5:1
FSL
WATER COURSE
$H_s$
H
D
0·5:1
1·5:1
Y
H
FSL
BED LEVEL
BED LEVEL
R = 2H
LONGITUDINAL SECTION

All dimensions in centimetres.

Fig. 4 Crump's Adjustable Proportional Module

12

1976 APM Standard



PLAN
SECTION.

CRUMPS
ADJUSTABLE PROPORTIONAL MODULE.

1922 APM Design

Indian Standard 7986, 1976, 12.

Sharma, 1934

Details of Paper Mache details of models

# Imagination:Sedimentation

How engineers' historical views persist in the present through the outlet

"*Technological knowledge comprises traditions of practice, which are properties of communities of technological practitioners. Technological traditions of practice comprise complex information physically embodied in a community of practitioners and in the hardware and software of which they are masters. Such traditions define an accepted mode of technical operation, the conventional system for accomplishing a specified technical task. Such traditions encompass aspects of relevant scientific theory, engineering design formulae, accepted procedures and methods, specialised instrumentation, and, often, elements of ideological rationale.* "
→ Constant, 1980

As an outsider to Engineering, the archival record would be illegible to me without the help of YouTubers explaining to me the engineering terms that are rooted in the early 20th century but remain in use today. This dynamic speaks to the persistence and naturalisation of the colonial engineering logic. Elsewhere, discussing modern day Indonesia, Ersten has shown how a similar situation occurs. He writes that:

"*The irrigation department at Delft University of Technology did not adapt its (East Indian) irrigation definition dating from 1898 (which includes drainage) to the international standard (which distinguishes between irrigation and drainage) until 1997.*" [Ersten, 2007, 4]

However what may persist as 'best practice' for a given engineering issue hand can be problematised by taking a more critical look at engineering practice. The history of the outlet shows that rationality is historically constructed.

Picon differentiates between logic and rationality in engineering to show the role of social ideals in the field. He writes that:

"*Rationality is not to be confused with logic at large. Contrary to logic, rationality is permeated by all sorts of historically determined factors like the representations of nature and man that prevail in a given society [...] Rather than the result of a solitary exercise of the mind, rationality is the product of interaction, communication, and conflict.*" [Picon, 2004, 431]

In other words, rationality is sedimentary. Picon further situates rationality as being co-dependent on imagination.:

"*Rationality is inseparable from imagination. At the intersection of the two, one finds among others the key notions of effectiveness and efficiency. Contrary to what most engineers postulate in their desire to ground their practice on an indisputable science and on a ahistorical rationality, effectiveness and efficiency are culturally constructed notions.*" [ibid]

What was rational to the Engineers of the Punjab in their pursuit of the outlet design was forged through their habitus [Bhattacharya 254]. It is through this understanding that the Punjab Engineering Congress can be seen as crucial.

Founded in 1913, the Punjab Engineer's congress served as a private forum for the dissemination of ideas amongst engineers. Comprised of those working within the Public works department of the Punjab (and select other engineers) its externality to the state structure (official engineering concepts were disseminated through "branch papers") produced a forum for engineers to disseminate concepts that arose through their official experience but refracted through a chamber of like-minded individuals. Instead of engineers according to a immutable/platonic logic in their designs, their contextual rationality became extremified in the setting of like-minded engineers.

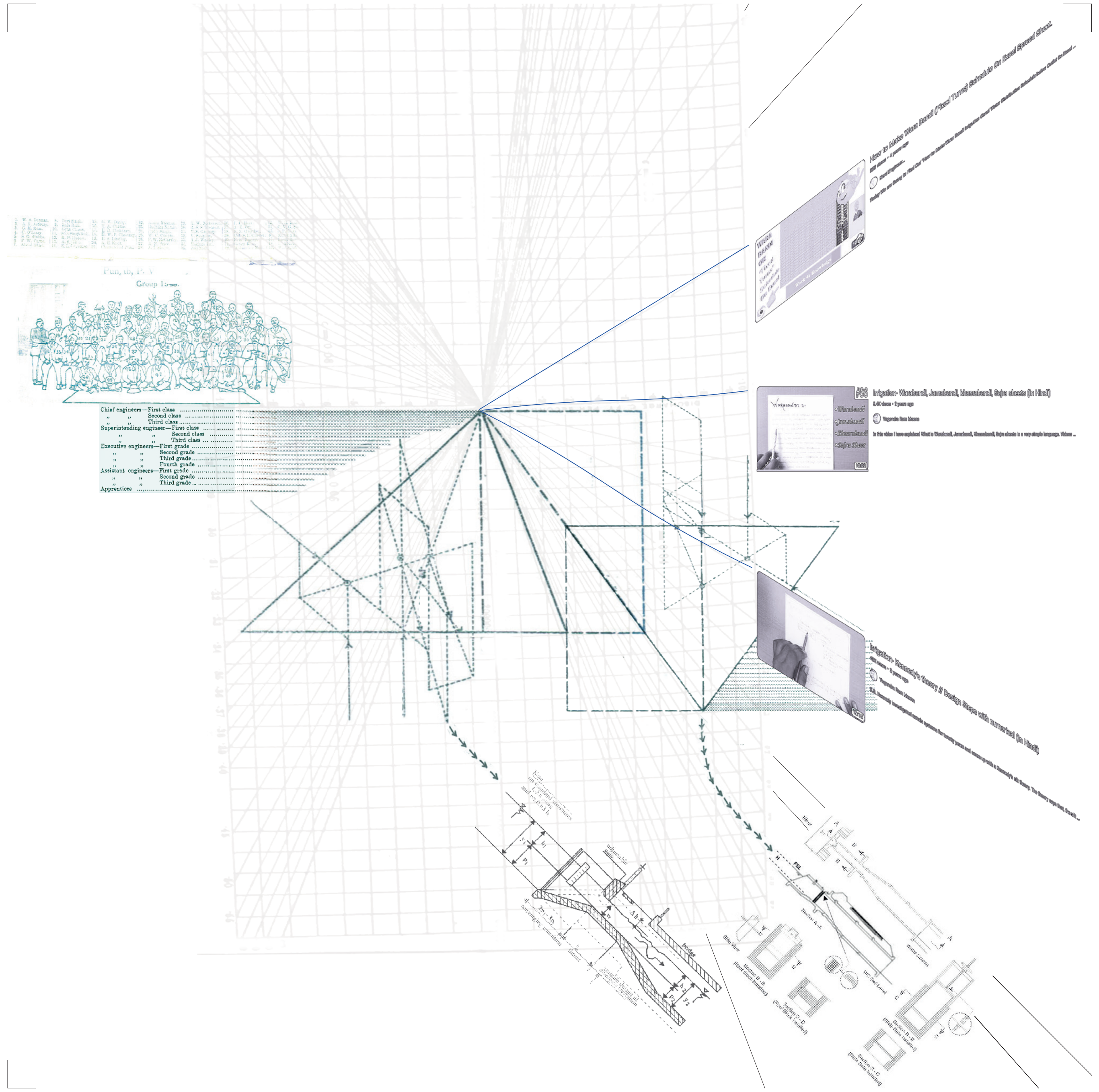
### The Case of Tubewells

Engineers' Desiderata's recurrent focus on steady, predictable flow of water, substrated by the taxation regime, meant that water was often wasted. Where the soil could not attenuate excess quickly enough, waterlogging would take hold.

Engineers sought to tackle this clear failing of their designs, however operated with a rationality that occluded their ability to see the cause of the problem: that the quest for proportionality was culpable. Instead, focus was turned to the use of Tubewells to alleviate the problem.

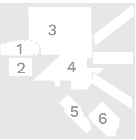
Following the widely published use of the "Abysinnian Tube Well" in British Military campaigns, mechanial wells were widely promoted in Engineering Publications in the late 19th century [Subramanian, 2015, 79]. In 1906 Tubewells were used to address waterlogging on the Upper Bari Doab Canal [Ashford, 1918, 1] In 1914, the second year of the Punjab Engineer's Congress, T.A Brownlie [1918] introduced a paper on their use within the Punjab.

As the APM became 'naturalised' in its use alongside changes in agricultural policy, gave the tubewell new-found prominence.



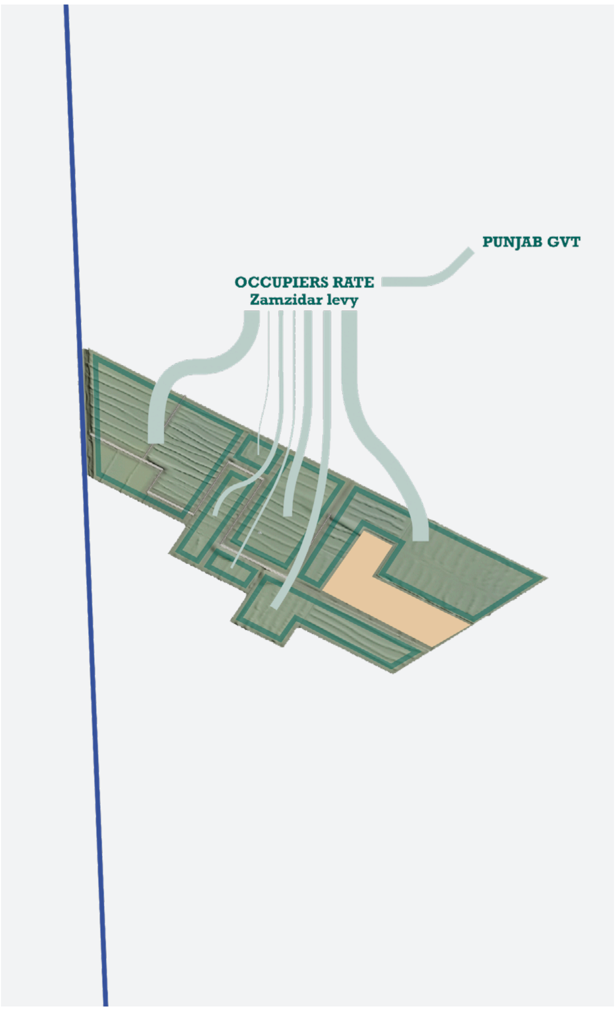
Collage situating the historical engineering rationalities with contemporary continuations

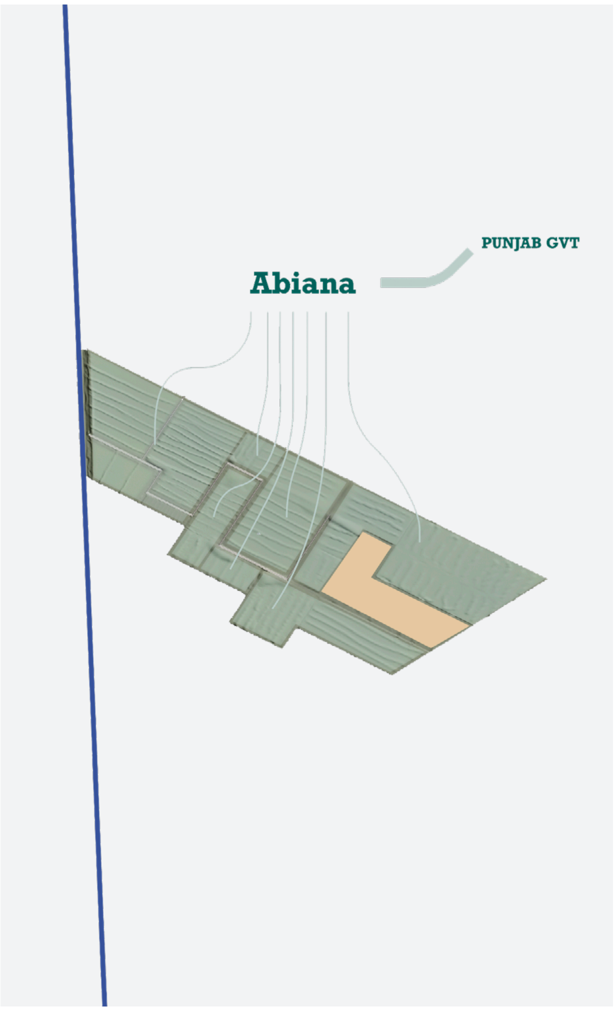
1 Punjab Engineering Congress, 1913, 3
2 The Artizan, 1876, 6
3 Branch Papers no 9, 1905
4 Schoneman, 1913, 11 5
5 Koei, 1996
6 Harza-Nespak, 1981

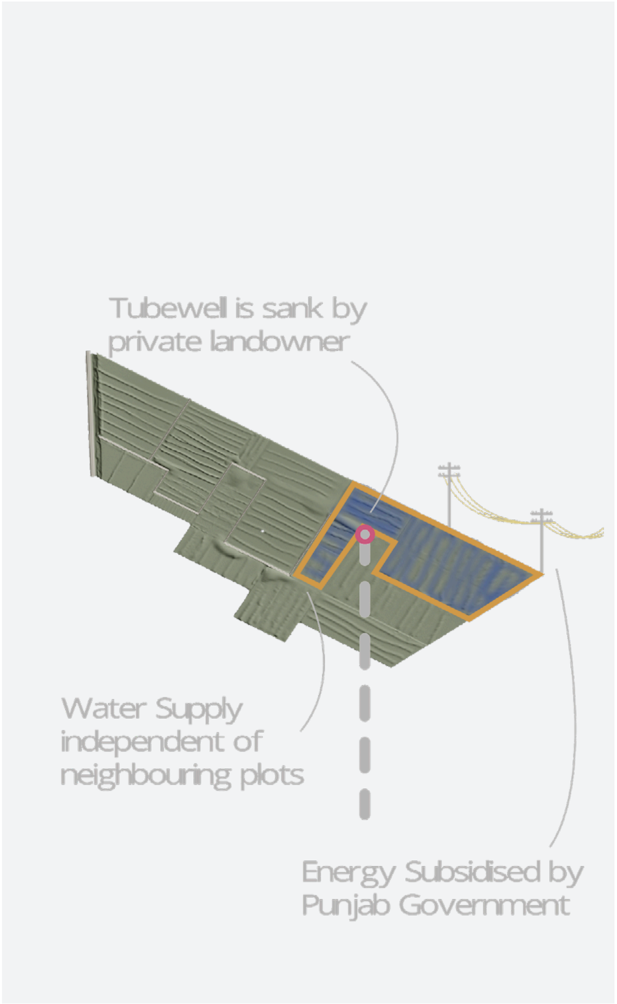


# Legislation:Specification

The outlet reproduces Raj-era water management

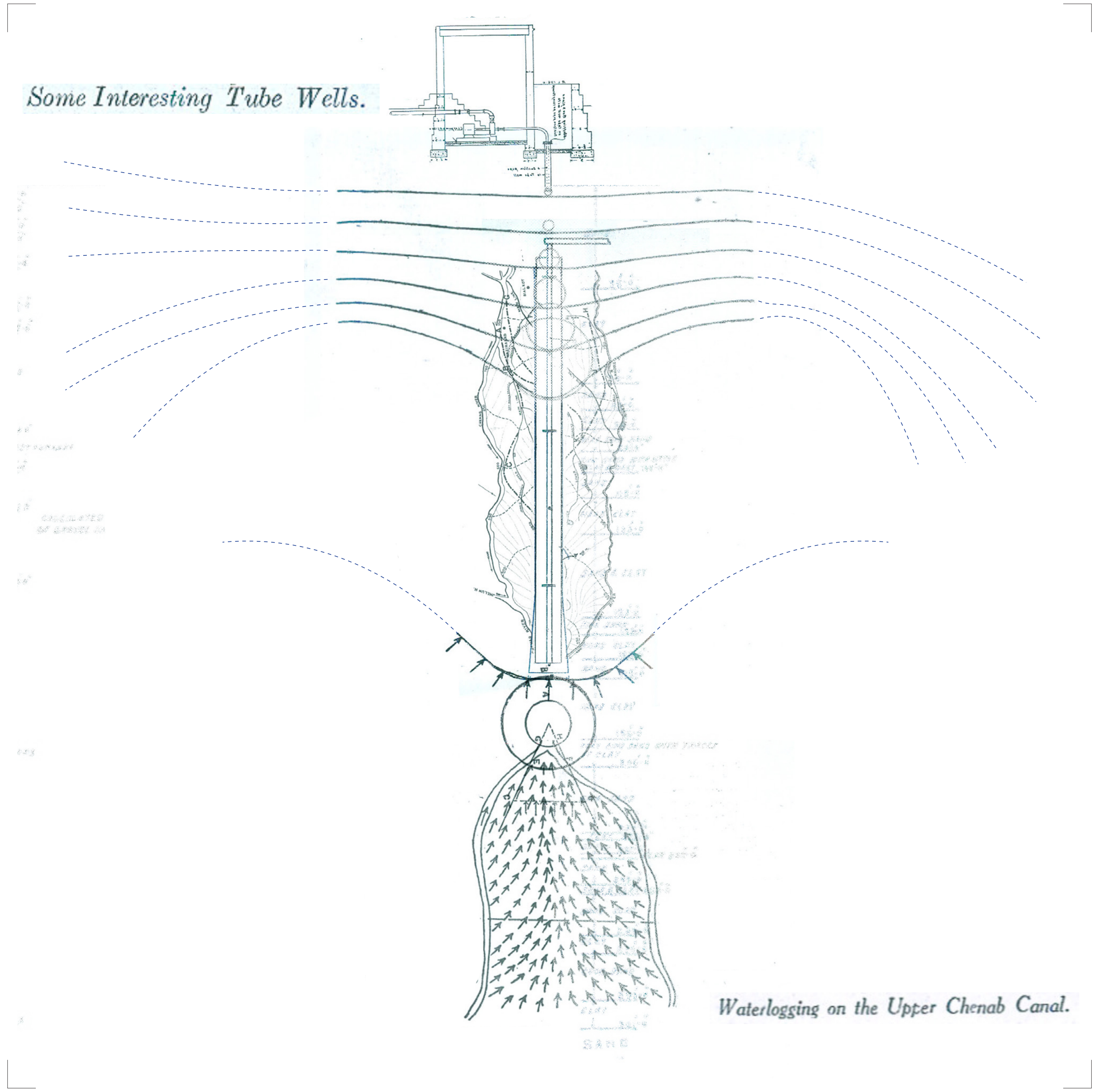

PUNJAB GVT
OCCUPIERS RATE
Zamzidar levy


PUNJAB GVT
Abiana


Tubewell is sank by private landowner
Water Supply independent of neighbouring plots
Energy Subsidised by Punjab Government

The design of the APM reflects the governance structures of its time. From 1872, taxation in the Punjab was based on an "occupiers rate" which taxed land based on area sewn [Bhattacharya, 2019, 398]. This model prioritised taxable land over the yield or productivity of the canal colonies, or the potential efficiency of water supplied. Within independent India initiatives such as the 1948 Grow More Food programme sought to achieve food-security and self sufficiency [Subramanian, 2015, 116]. This change in focus from tax extraction to requisite food supply led to changes to taxation, where in Independent India tax was levied on the type of crop being sewn and not whether it was canal-irrigated.

Changes to taxation and national food policies incentivised the sinking of private tubewells. While the state held total ownership to above ground water through the 1873 Canal Act [Northern India Canal and Drainage Act, 1873], the subsoil water was technically private, allowing farmers to sink tubewells and increase their farming of high-water consuming crops.

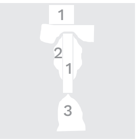

Some Interesting Tube Wells.
Waterlogging on the Upper Chenab Canal.

Collage. Through the unsuitability of the APM the tubewell has become widely used in the Punjab.

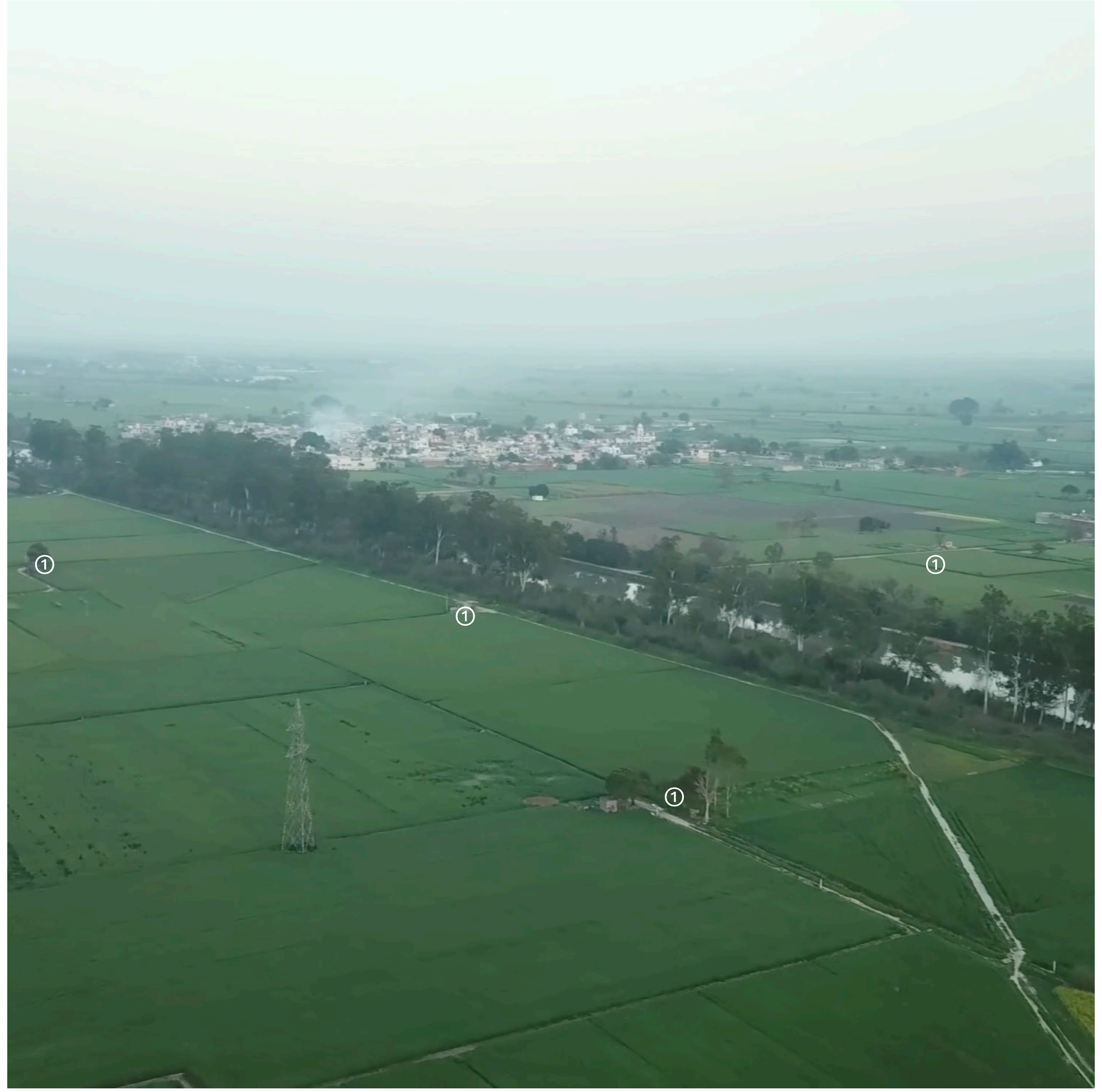
1 Vardon, 1930

2 May, 1918

3 Elsden, 1921



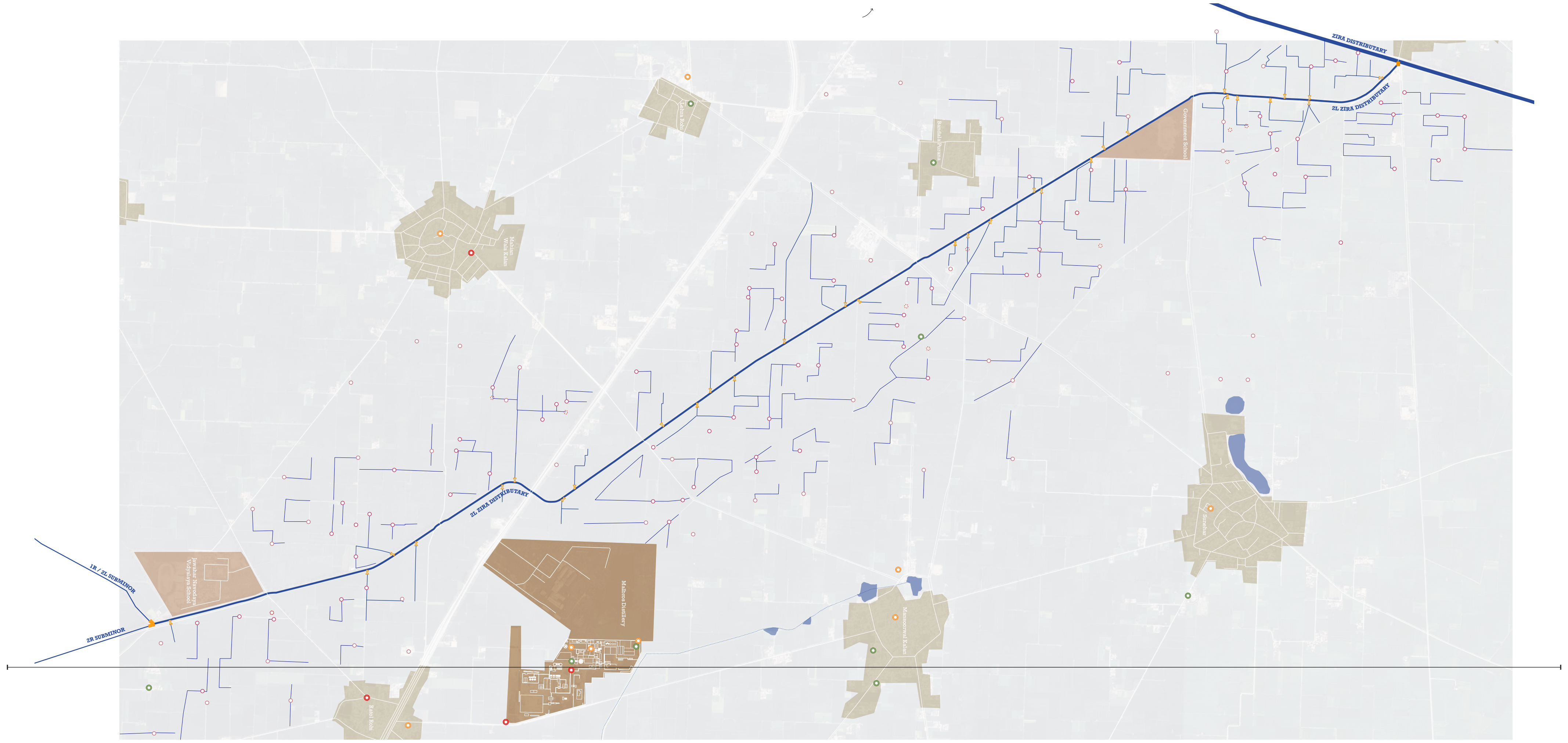
Mechanical Tubewell extracting water from the below ground aquifer. Asadwarraich, 2016



Tubewells ① operational within fields also irrigated by canal outlets. Ballowal, 2019.

## Extraction:Contamination

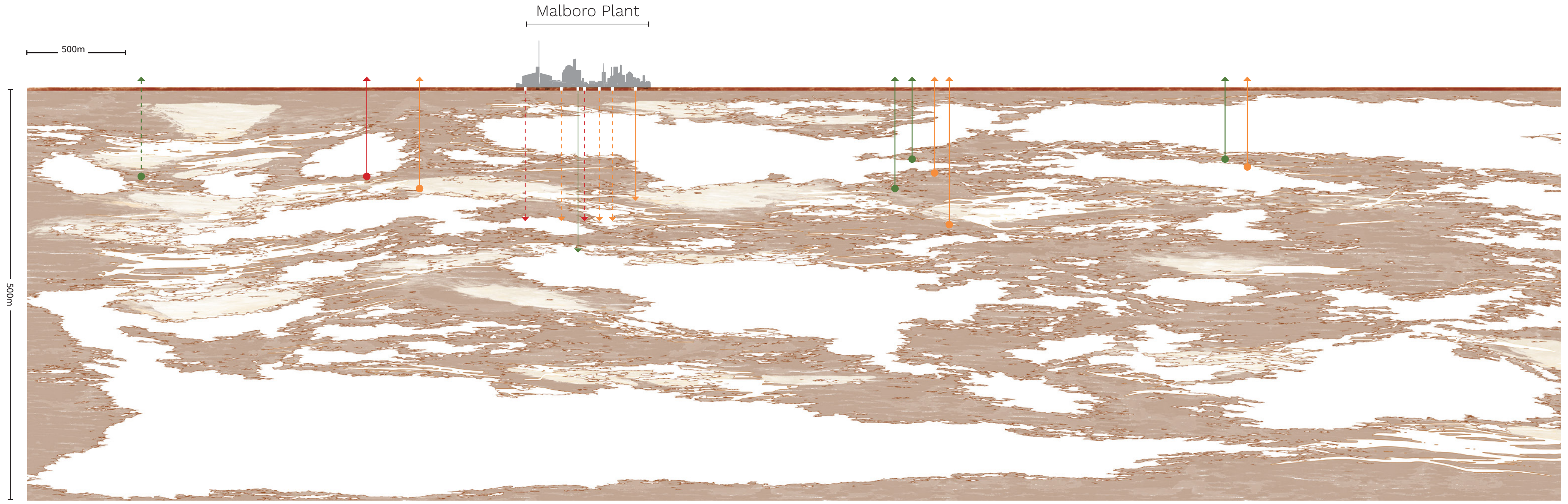
Contamination of the substrate and its affect on tubewell water



Map of Tubewells along the Zira 2L Distributary, Sidhwan Branch, Sirhind Canal. A laissez-faire attitude to sinking tubewells, combined with lax regulations on ethanol production at the Malbros Factory, produced conditions for widespread contamination of groundwater in the region.

Following the death of Rajvir Singh in December 2022, The Bharti Kisan Union (BKU) protested by blockading the Malbros factory site.
In May 2023, it was found that the plant was illegally reverse-pumping spent-wash (highly toxic ethanol by-product) directly into the aquifers below, through at least 25 illegally sunk tubewells [CPCB, 2023].

Canal; ▬ Distributary ▬ Minor — Subminor①
Outlet; ⋈ Flume — Field Channel
Drains; ● Water Body - - Former Inundation Canal②
**Wells;** ○ 1997① ○ 2023③ ◌ Abandoned (1921)②
▨ Village / Town ▨ Non-Resi ▨ **Malboro**
⊢⊣ Section Line
Wells Tested:
Colourless & Odourless Water ○
Unpleasant Odour ○
Odour and blackish colour water ○

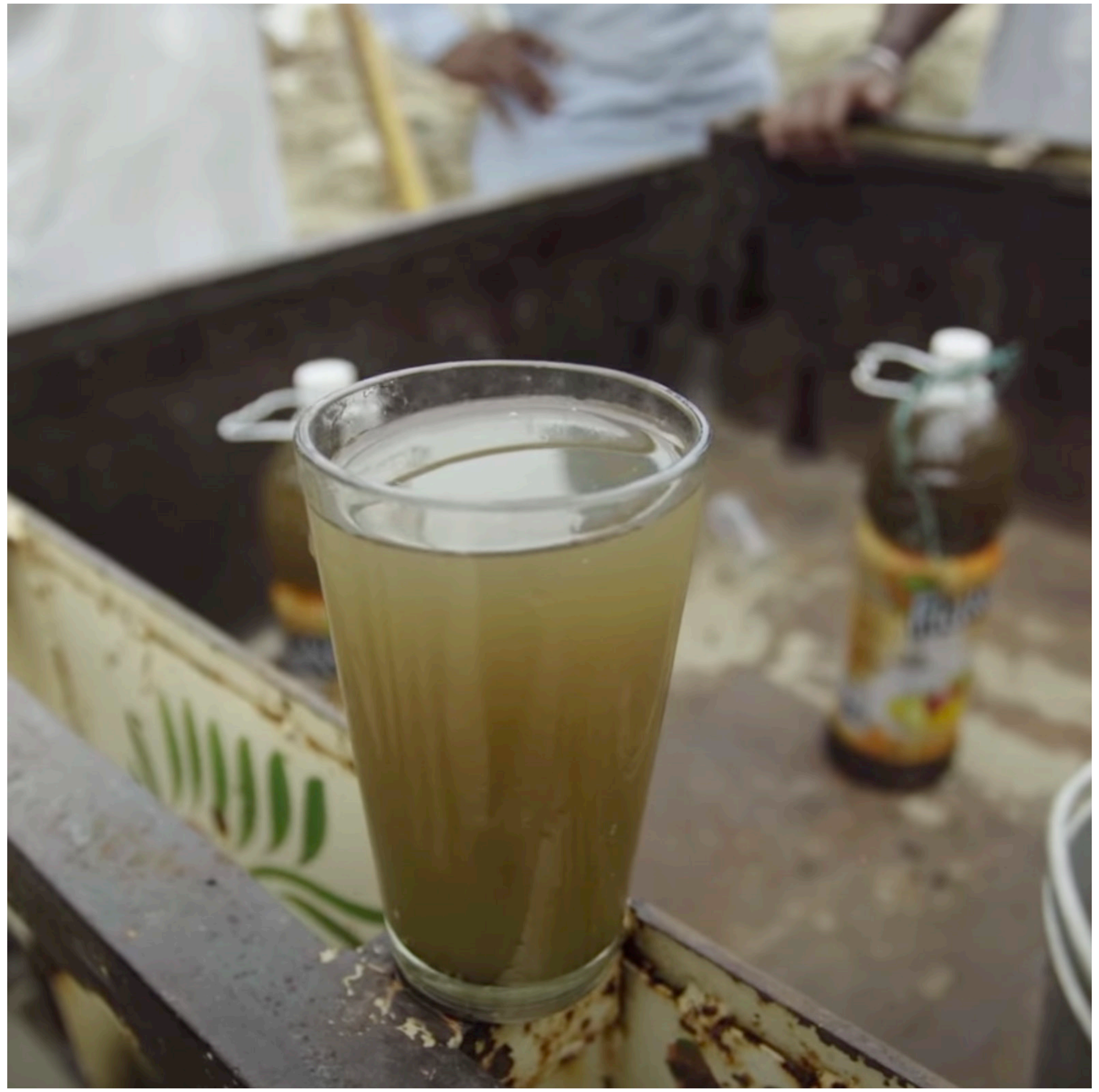


As outlined in the previous chapter, knowledge of the subsoil remains limited, and continues to conform to reductionist models. The complex, invisible architectures of the aquifers means that the true path that pollutants take through the subsoil is inaccessible.

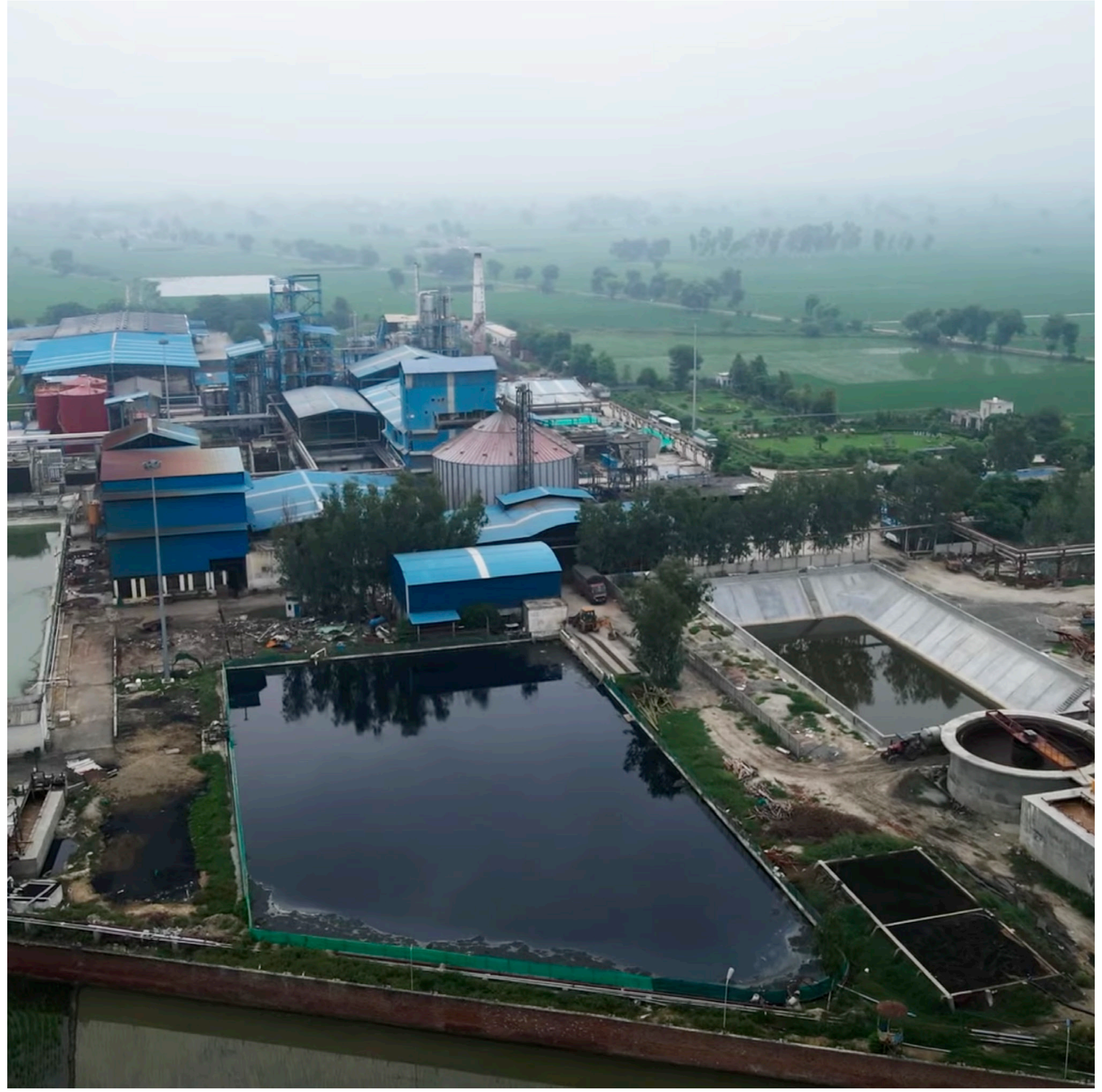
Wells Tested:
Colourless & Odourless Water ○
Unpleasant Odour ○
Odour and blackish colour water ○
Section Line ⊢⊣

① Survey of India Open Series Map, 1997 ② Survey of India 1921 Series ③ Maxar via Google Earth.
All Outlet locations digitised based on satellite imagery and referenced against available outlet layout plans. Roads via Open Street Map

Test data derived from REPLY AFFIDAVIT ON BEHALF OF RESPONDENT NO. 5, CENTRAL POLLUTION CONTROL BOARD, (CPCB), 19th May 2023. Available at: https://greentribunal.gov.in/sites/default/files/news_updates/Reply%20Affidavit%20by%20R-5%20(CPCB)%20in%20OA%20No.%20606%20of%202022%20(Public%20Action%20Committee%20&%20Ors.%20Vs.%20State%20of%20Punjab%20&%20Others).pdf



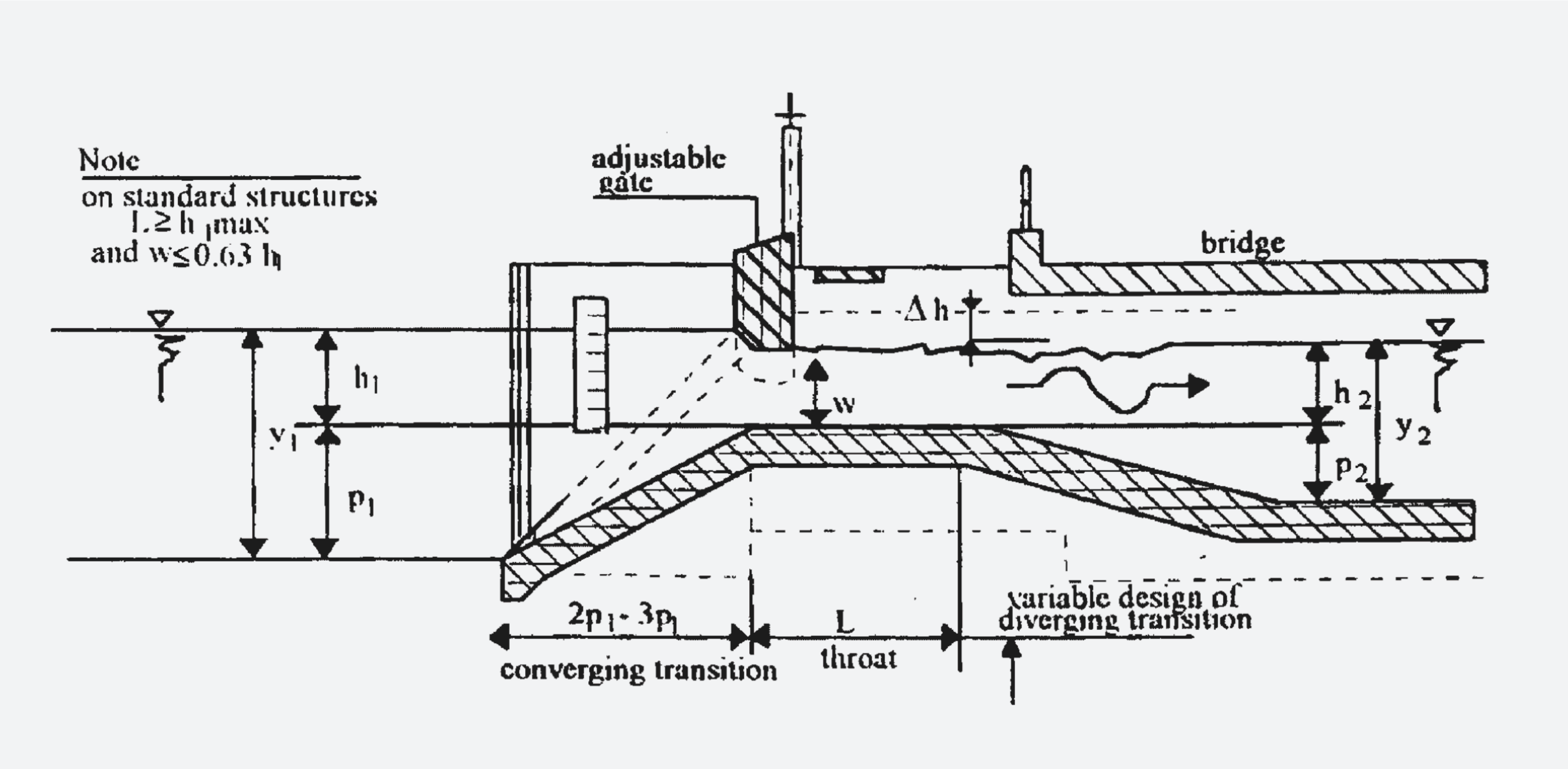
Water at the Zira Morcha Protest from a
tubewell, showing contamination of the aquifer
it was pumped from. Trolley Times, 2022



Storage tanks for spent wash (highly toxic waste product
of ethanol) at Malbros factory, Zira. Trolley Times, 2022

# Desiderata:Divergence

How the problems of the APM have been identified


Note
on standard structures
1.2 ≥ h1max
and w≤0.63 h1
adjustable gate
bridge
Δh
h1
y1
p1
w
h2
y2
p2
2p1 - 3p1
converging transition
L
throat
variable design of diverging transition

Section of the Crump-De Gruyter (CDG) outlet [Koei, 1986 via Ersten, 2007, 6]. Invented in 1925 by the Dutch Engineer De-Gruyter epitomises how how engineering desiderata - as a stratified blend of political, economical and resultant rationale - determine the relative success or failure of infrastructural design.

The CDG was deployed within the Dutch East Indies (Modern day Indonesia). Where Punjab Canal Colonies levied taxation on irrigated land, the Dutch exacted compulsory labouring on land to produce export crops. This shifted the focus on taxable land to actual product yield. [Ibid, 7]

In response, the CDG design seeks to provide requisite water discharge to ensure maximum crop yields. It does this by having a truly adjustable head-block that can be moved to differ intake through the year and for different seasons. This design has its own problematics for post-independence irrigation, but highlights the spatial and political contingencies in what constitutes a rational design.

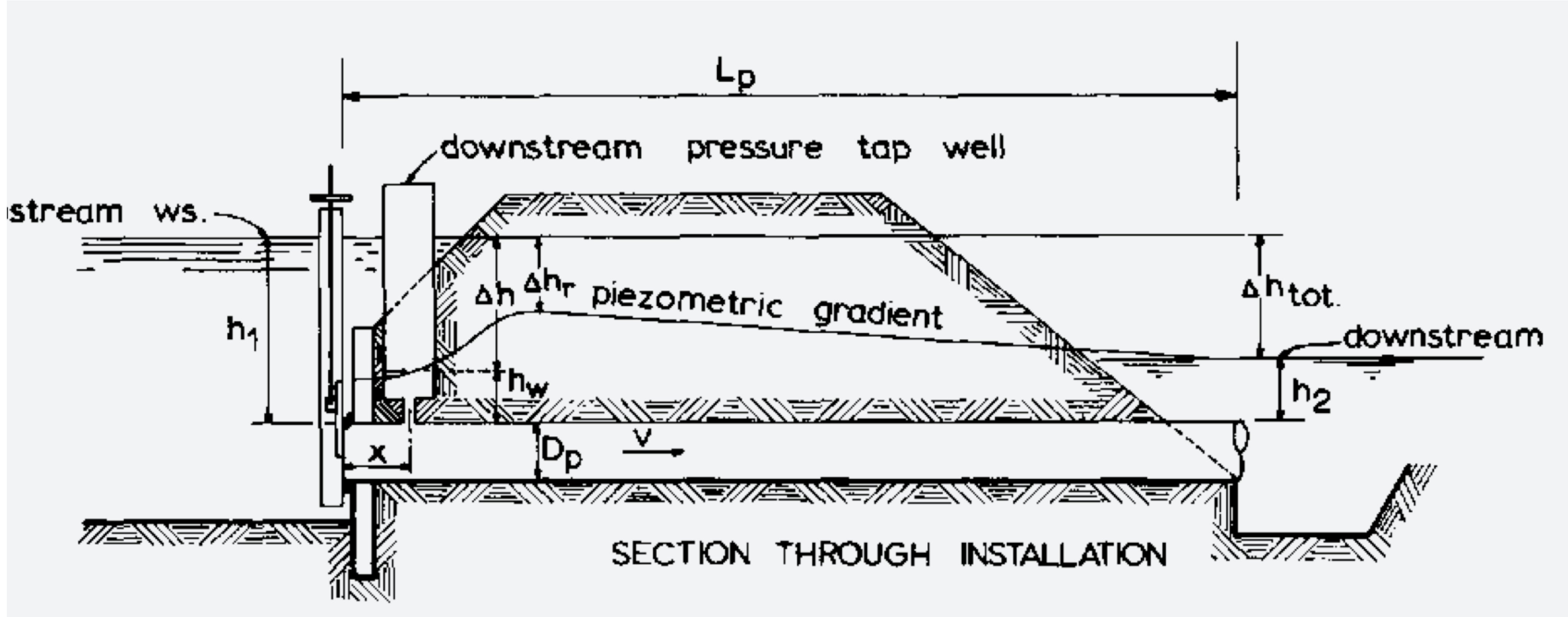

Lp
downstream pressure tap well
stream ws.
h1
Δh
Δhr
piezometric gradient
Δhtot.
downstream
h2
hw
x
Dp
v
SECTION THROUGH INSTALLATION

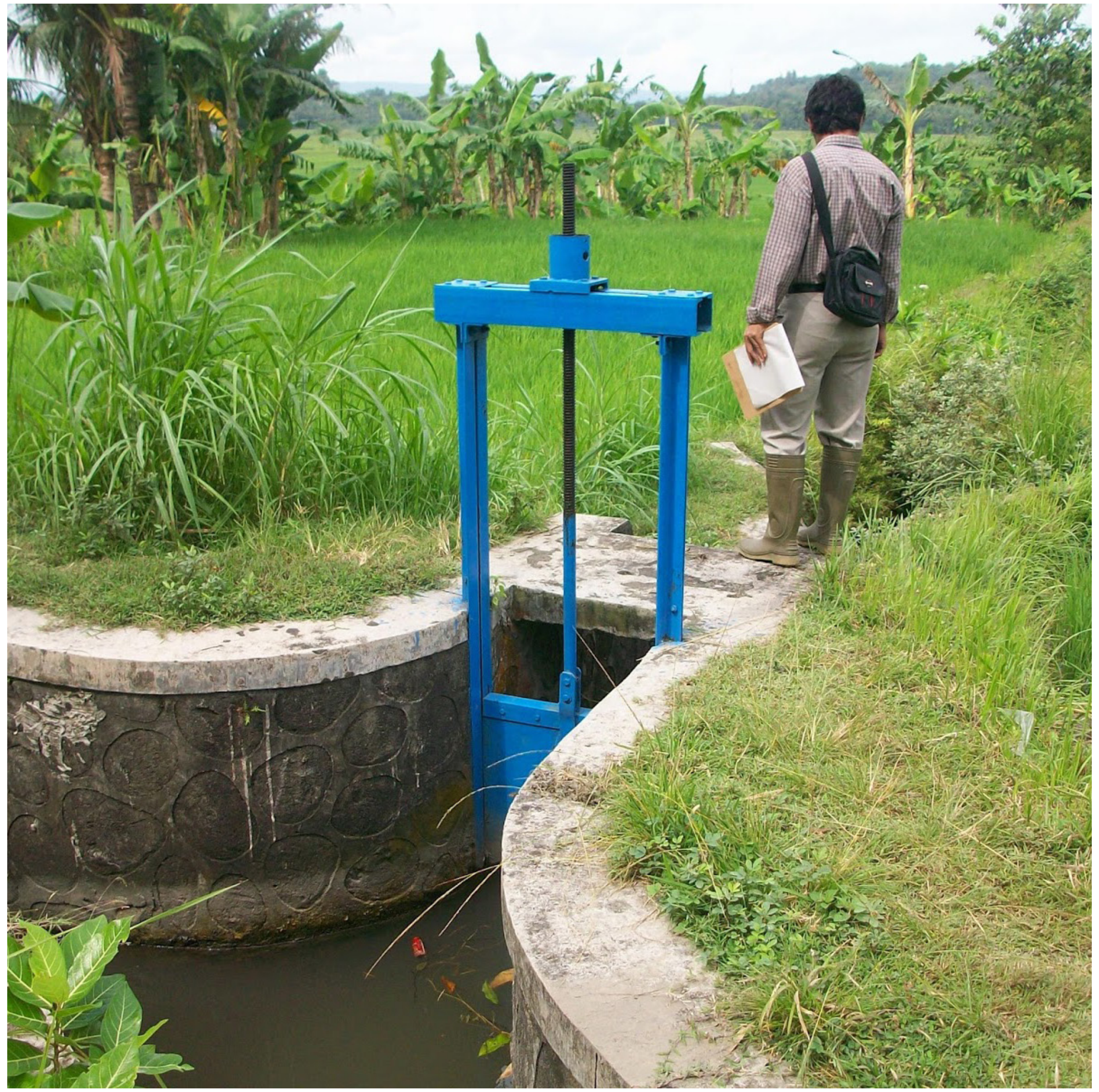
*Fig.8.19. Example of metergate installation (USBR, 1961).*

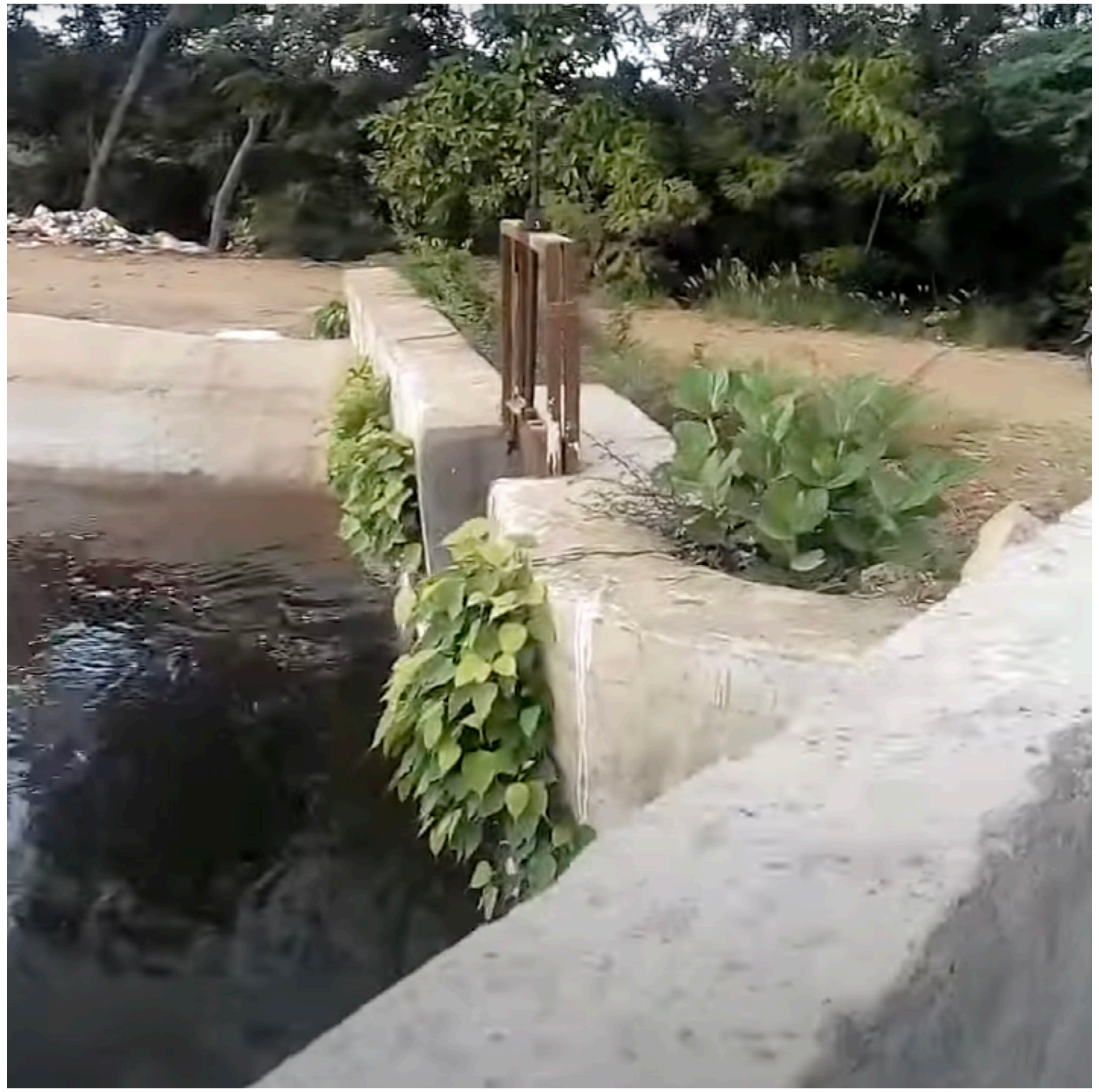
Section through typical metergate outlet [Bos, 1976]. Following the Indus Water Treaty, Pakistan's water access was fundamentally altered and alongside divergent agricultural policies the need for a different canal irrigation system became apparent.

Van Halsema writes "For the first time, these projects aimed at establishing a new irrigation concept in which the operation and management of water delivery would be specifically geared at responding to the crop requirements" [van Halsema, 2002, 112].

A crop-first approach is familial to the CDG design, but because Crump APM was already commonplace (and had continued to be installed across the Pakistan region post-partition), it was proposed to continue to install Crump APMs and later modify them. Ultimately, this was scrapped in favour of American style Meter Gates. (shown above). It is design interventions by multinational companies such as this that have been highlighted bysupporters of Pakistan's Cop27 calls for loss and damage payments [Raza, 2022].

The divergence from the APM is not necessarily an endorsement of these alternative outlets; as outlined in van Halsema's writing they are also fraught with issues. Rarther, it is to show that the "standardisation" of the APM is not representative of an objective quality in its design



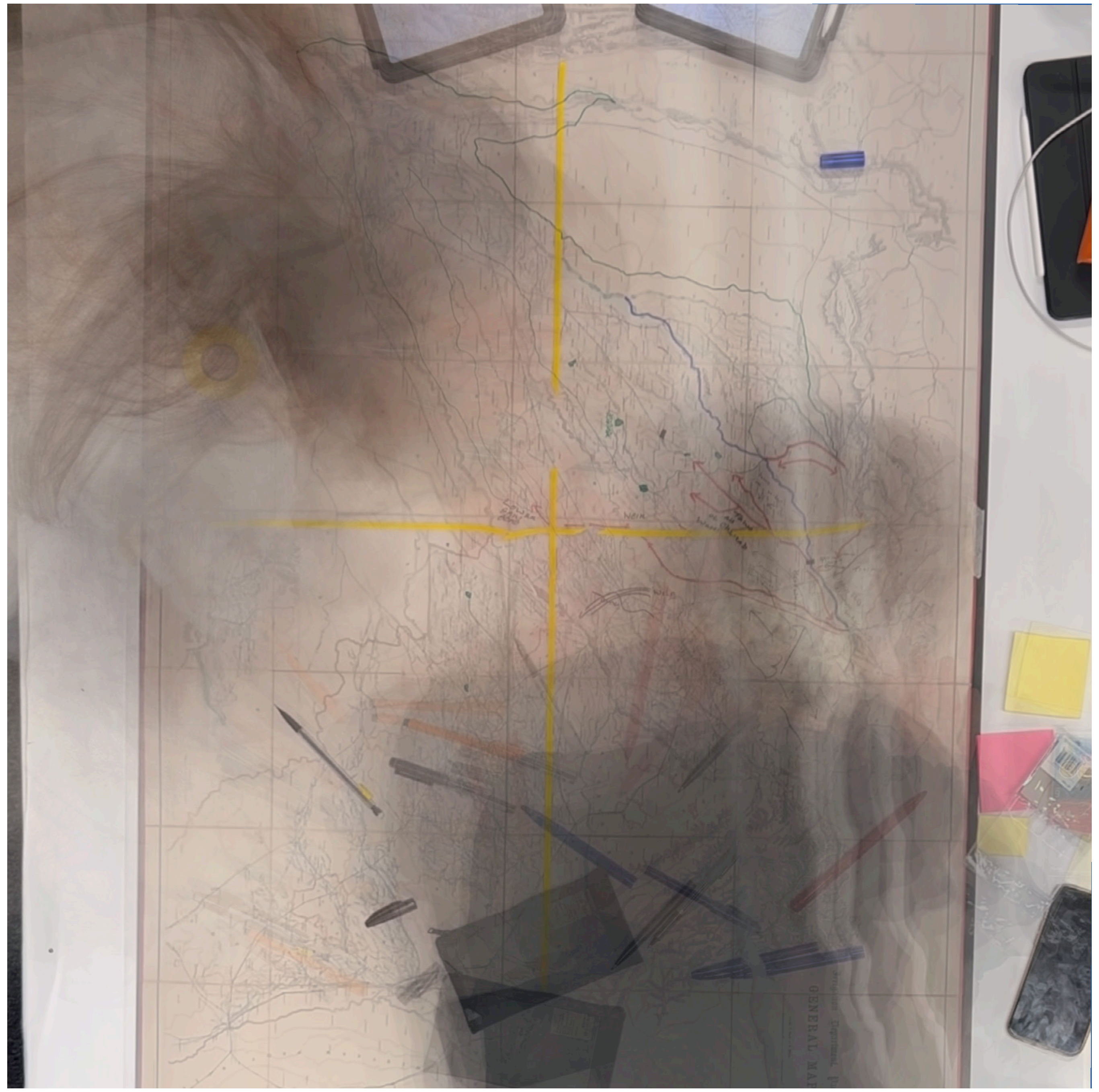


Crump de Gruyter Outlet,
Indonesia. Damarverrygood, 2016

Meter Gate installed in Pakistan. Principle difference between the two designs is in the setback from the source canal. Patel, 2017

④

# Archiving : Recording



Collaborative annotation of 1906 Triple Canal Project map as a means to develop our understanding.
Composite overlaying of stills from recording

# Archiving:Recording

*The Red of expanding British Territory soon covered maps of the subcontinent, to be followed shortly by the white of paperwork that characterised the transfer of bureaucratic government to newly conquered areas*
→ Barrier, 1969, 2

*Soon after independence, the Kenyan and Indian governments began to lodge protests in London, calling for the return of their archives, which the British state had stolen or destroyed to mask their well-documented histories of colonial indiscretions.23 At the same time, indigenous peoples from the former Dominions of Australia, New Zealand, and Canada regularly came to London after 1968 to make claims for sovereignty and rights on the British crown. Millions of British passport holders from around the world also sought to exercise their legal right of entry into Britain, despite successive governments' best efforts to narrow the definition of citizenship. The empire - both Britain's remaining formal colonies and an array of late imperial obligations and legal challenges at home and around the world - could not be shaken off so easily.*
→ Hebert, 2019, 10

The India Office Library (IOL) is the name given to all material in the posession of the Government of India and based in London at the time of independence/partition. The India Office Records (IOR) sit within this, and are comprised of administrative records from the Raj. Today, the IOR is housed within the British Library, London, within its Asia and Africa Studies collection.

The records' status as being housed with the UK remains controversial, with a long running, multifacted dispute over ownership. Throughout this year's project(s) I have explored different means of engagement with the archival material and how it serves as a "substrate" [Derrida, 1995] for authority. The archival/textual substrate has a direct, active relation with the substrata of the Punjab, through the design and ongoing operation of the Canal outlet.

The treatment of the archival as a source of authority has also meant that the British Library can serve as a site of intervention. Following Carolyn Steedman's development of Derrida's Archive Fever, The British Library's legislated role as the site of 'Legal Deposit' means that it is both a site of harbouring contested archives (the IOR) but also a porous site which necessitates published work to be deposited within it. Through this, my work in engaging with the problematics of the archival and the geologic real can become an intervention into that same archive by simply following the law.

Beyond the British Library, the landscape of archival practice pertaining to the Punjab is multifaceted. Alongside the aforementioned Punjab Engineer's congress, there has been myriad other means to de-sediment the archival role that the British Library has towards creating more diverse, grassroots archives.

**Keywords**

→ Archive
From Arkhe, both commencement and Commandment [Derrida, 1995, 9]. Yet also Arkheion - house, domicile, and the address of a magistrate - the archon [ibid, 10]. Therefore the archive is the 'dwelling' of the 'substrate' (textual records) which signify both commencement (beginnings) and commandment (power).

→ Legal Deposit
Requirement for all publications (including private/self-published) to have a copy deposited with the British Library. Other copyright libraries may also request editions [Legal Deposits Act, 2003]

→ Public Record
Governmental documents which are to be (eventually) realised to the public [Public Records Act, 1958].

→ Repatriation
The return of something. The India Officer Record's controversy lies in whether present day India, Pakistan and Bangladesh are the successors to the colonial Government of India, or instead if it is the UK government.

→ Substrate
For Derrida, a substrate is a surface that can be subject to inscription [Philips, 2022, Abstract]. The documents within the archive are thus a substrate, but so too is the geological substrata that hold 'memory' of the engineering actions enacted on them.

## Timeline of Key Events

| | | |
|---|---|---|
| 1801 | **Foundation of India Office Library by East India Company (EIC)** | |
| 1857 | **Indian Uprising** | |
| 1858 | **Government of India Act**<br>Foundation of Government of India (GOI) (British Raj). Beginning of India Office Records<br>EIC Records purchased by GOI | From 1858 to 1920, India Office Records (IOR) were paid for by the Government of India. India Office Records were excluded from Public Records<br>Purchased for sum of £37,200,000 (3.6b in 2023). 300 tonnes sold as wastepaper |
| 1864 | **Purchase of future archive site**<br>King Charles Street | Purchased by Secretary of State for India for £86,765 (£9,000,000 in 2023 money). Vest in Crown ownership "for the services of the Government of India" and therefore not the services of HMG (UK parliamentary govenrment) |
| 1870 | **Completion of archive Building** | Costing £588,000 (£57,000,000 in 2023 money). Paid for by Government of India Revenue. Storing the India office Library, in which the India office Records are contained. |
| 1911 | **Copyright Act 1911** | |
| 1911 | **Foundation of Engineering Congress** | |
| 1919 | **Government of India Act** | Reduction in Government of India contribution for maintenance of archive to 40% of costs |
| 1935 | **Government of India Act** | Prevents the sale or transfer of any lands or buildings vested in the crown for the purpose of HMG without the Governor General (viceroy)'s consent (Chp 3 Cl 172 (2)) |
| 1947 | **Indian Independence Act** | Draft Clauses stipulating control and ownership of the archive were omitted on the instruction of Mountbatten, with concern over competiting claims from independent India and newly-formed Pakistan |
| 1947 | **Partition and formation of India, and East West Pakistan** | |
| 1949 | **Limited return of items in IOL** | Budhist relics returned to India and re-interned in 1952. |
| 1921 | **Punjab Engineering Congress re-formed as Pakistan Engineering Congress** | |
| 1955 | **Joint India-Pakistan Comunique**<br>**Claiming ownership over IOL (and IOR)** | Part of agreement to divide material with ~ 17.5% going to Pakistan, divided mainly along language.<br>Pushback from HMG claiming that under the 1935 HMG owned the library |
| 1959 | **Joint India Pakistan Aide-Memoire** | Citing the legal history from 1864 as claim of ownership, alongside moral claims |
| 1960 | **Proposal of UK-India-Pakistan Trust** | Ownership of the archive to then be vested in the trust which would be modelled after the British Museum |
| 1960 | **Indus Water Treaty** | Issue of the IOL/IOR discussed by leaders at signing ceremony |
| 1960 | **Brief revelation that IOR was brought into Public Record** | Meaning that any future claim over the IOL must now exclude the India Office record |
| 1967 | **Movement of India Office Records** | Modern classification system introduced |
| 1971 | **Provincial Govenrment of Bangladesh Formed** | |
| 1972 | **British Library Act**<br>**British Library Opened 1973** | Initially the Library was housed at locations across London and at Boston Spa, West Yorkshire |
| 1982 | **India Office Record moved to British Library** | Under Public Records system means it can be accessed / consulted by the public |
| 2003 | **Legal Deposits Act** | Requiring all publications to have a copy submitted to the British Library |

Geological Survey of India [1877], British Library

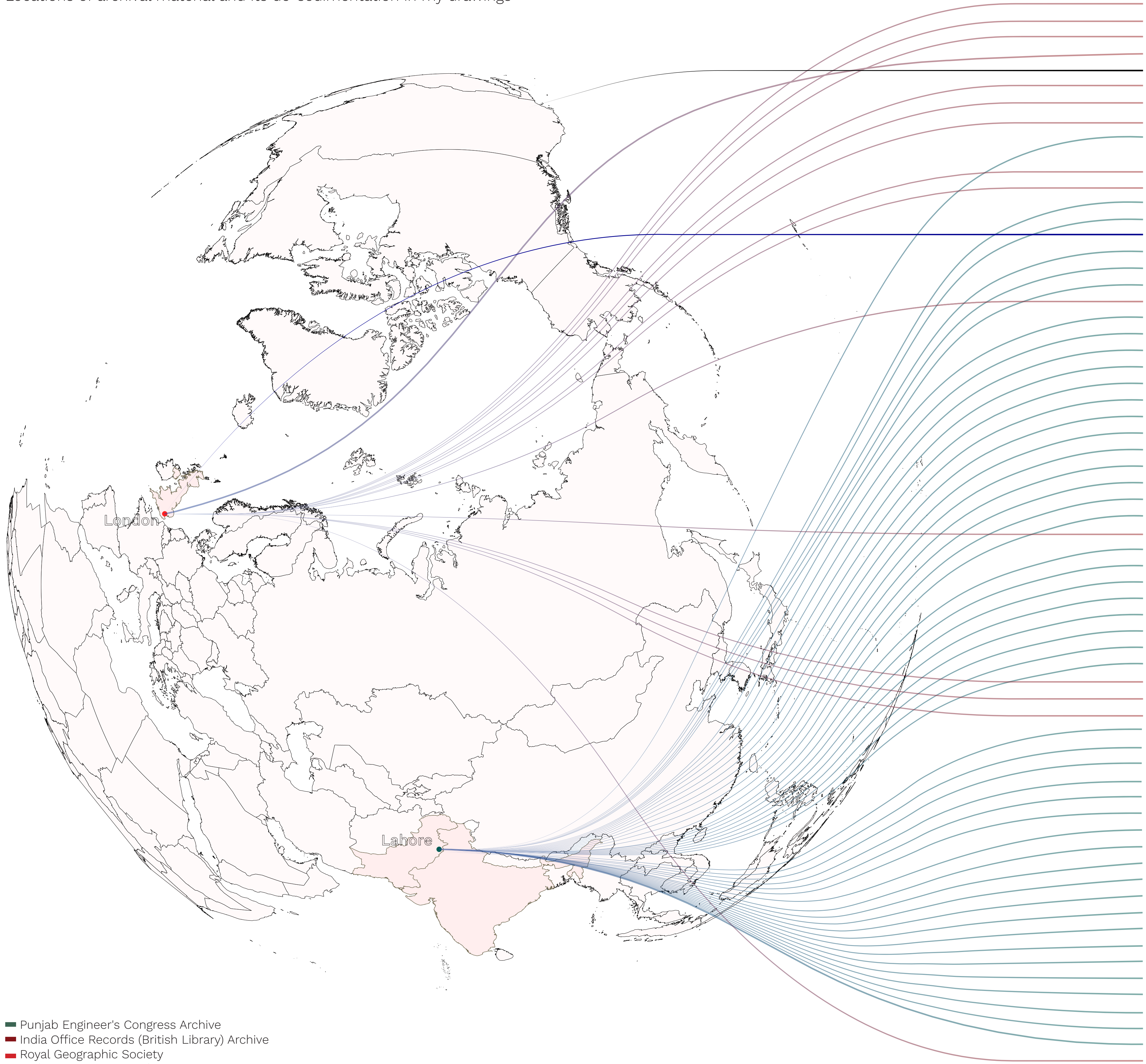
The India Office Records archive continues to be a sight of political struggle. its current location is the result of a decades long dispute over ownership and restitution. Numerous proposals for repatriation, duplication, triplication, and dissemination of the textual material have been made by India and Pakistan, both collectively and sepately, to repatriate the records. Because the India Office Library's upkeep was funded via Government of India revenue during direct rule, it was argued that the India Office Records within it were not 'Public Records' - the status given to most government documents [Ankit, 2022, 166].It also meant these documents were not owned by the UK government, but instead owned by the Crown on behalf of the Government of India (GOI). Once India and Pakistan became independent and the GOI was dissolved, the archive, physically in London within a building which was paid for by the GOI's revenue, became contested. However the 1958 Public Records Act in the UK quashed legal challenges, rendering the IOR part of the UK public record [ibid, 179]. This legal entrenching of UK ownership over the archive (not withstanding differing legal readings and moral objections) also meant that the India Office Record was to be made publicly available for people to access.

In 1982, the India Office Records were transfered to the British Library (BL), where they remain today. It is through the BL that I have had access to the material forming this project.

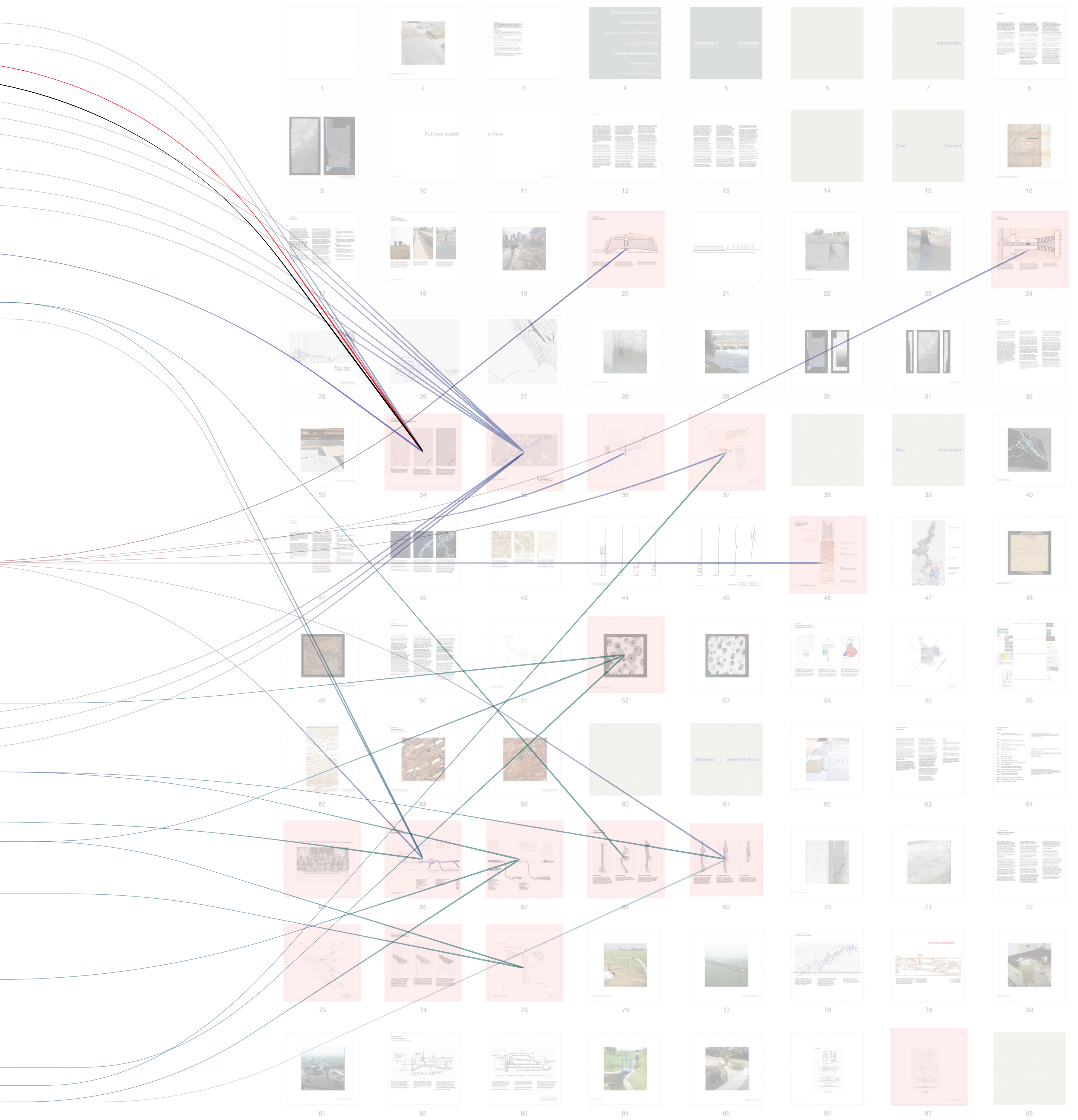
Archiving:Recording

# Substrate:Source

Locations of archival material and its de-sedimentation in my drawings



| | | |
|---|---|---|
| 1877 | BLANDFORD | A MANUAL OF THE GEOLOGY OF INDIA |
| 1882 | ANON | DESCRIPTIVE SKETCH OF THE SIRHIND CANAL, |
| 1899 | PUBLIC WORKS | REVENUE REPORT OF THE IRRIGATION DEPARTMENT, |
| 1906 | BENTON | PUNJAB TRIPLE CANAL PROJECT |
| 1912 | GREY | TALES OF OUR GRANDFATHER |
| 1912 | SURVEY OF INDIA | NO. 44 J/NE, 1:126:720 |
| 1912 | SURVEY OF INDIA | NO. 44 J/NW, 1:126:720 |
| 1912 | SURVEY OF INDIA | NO. 44 M/SE 1:126:720 |
| 1913 | A.J.WADLEY | THE FORMATION OF LAND BY RIVERS AND TORRENTS IN |
| 1913 | SURVEY OF INDIA | NO. 44 N/NE 1:126:720 |
| 1913 | SURVEY OF INDIA | NO. 44 J/13 |
| 1913 | SURVEY OF INDIA | 1:126:720 |
| 1914 | T.A.MILLER- | TUBE WELLS |
| 1915 | H.W. NICHOLSON | THE TRAINING WORKS AT THE SUTLAJ AT RUPAR |
| 1916 | BENTON | PUNJAB TRIPLE CANAL PROJECT |
| 1916 | F.V. ELSDON | DISTRIBUTARY OFFTAKES IN RELATION TO SILT |
| 1917 | .W SCHONEMANN | THE ABSORPTION LOSSES OF PUNJAB IRRIGATION |
| 1917 | B.P. VARMA | CANAL OUTLETS |
| 1917 | GIBB, AS | GIBB'S MODULE : ORIGINAL TYPE / PUNJAB IRRIGATION |
| 1918 | C.G. MAY | THE SUB-SOIL WATER TABLE UNDER THE TRACT |
| 1918 | JOHN ASHFORD | NOTES ON TUBEWELLS |
| 1918 | C.G. MAY | THE SUB-SOIL WATER TABLE UNDER THE TRACT |
| 1918 | JOHN ASHFORD | NOTES ON TUBEWELLS |
| 1918 | C.G. MAY | THE SUB-SOIL WATER TABLE UNDER THE TRACT |
| 1918 | T.A. MILLER | WATER SUPPLY FROM TUBEWELLS |
| 1918 | JOHN ASHFORD | NOTES ON TUBEWELLS |
| 1919 | E.S. LINDLEY | REGIME CHANNELS |
| 1919 | IQBAL HUSSAIN | WATER-LOGGING |
| 1921 | F.V. ELSDON | WATER-LOGGING FROM IRRIGATION CANALS IN ALLUVIAL |
| 1921 | W.P. THOMPSON | DRAINS ON THE LOWER CHENAB CANAL |
| 1921 | .V. ELSDON | WATER-LOGGING FROM IRRIGATION CANALS IN ALLUVIAL |
| 1922 | J.H.T. MIDDLETON | SUB-SOIL WATER IN THE PUNJAB PLAINS. |
| 1922 | E.S CRUMP | MODULING OF IRRIGATION CHANNELS |
| 1923 | B.H. WILSDON | PERCOLATION AND ABSORPTION OF WATER IN THE SOIL |
| 1923 | E.S. LINDLEY | THE APPLICATION OF MODULES IN IRRIGATION |
| 1926 | MR. B.H. WILDSON | THE SUB-SOIL WATER TABLE, AND METHODS OF ITS |
| 1926 | PIR MUHAMMED | DESIGN OF CANALS. |
| 1928 | P. CLAXTON | INUNDATION CANAL PRACTICE. |
| 1928 | P. CLAXTON | INUNDATION CANAL PRACTICE. |
| 1928 | WILSDON | THE TREATMENT OF WATER-LOGGED OR THREATENED |
| 1930 | N.K. BOSE | EXPONENTIAL LAW OF SUB-SOIL FLOW. |
| 1930 | SURVEY OF INDIA | NO. 44 I/SW, 1:126:720 |
| 1930 | SURVEY OF INDIA | NO. 44 I/SE, 1:126:720 |
| 1930 | SURVEY OF INDIA | NO. 44 M/SW 1:126:720 |
| 1931 | K.R. SHARMA | A THEORETICAL DESIGN OF A NEW TYPE OF OUTLET FOR |
| 1932 | RAJBANSI LAL | SOME EXAMPLES OF CONTROL OF FLOODS IN TORRENTS |
| 1933 | PANDIT K.R. | SILT CONDUCTION BY IRRIGATION OUTLETS. PANDIT |
| 1934 | PANDIT K.R. | ON THE DESIGN OF AN A.P.M. |
| 1935 | T. BLENCH | THE LACY SLOPE FORMULA. |
| 1936 | T. BLENCH | SCIENTIFIC IRRIGATION CHANNEL DESIGN. |
| 1936 | DR. N.K. BOSE | SILT-MOVEMENT AND DESIGN OF CHANNELS. |
| 1936 | RAI BAHADUR B.N. | WATER-LOGGING ON THE UPPER CHENAB CANAL - ITS |
| 1937 | T. BLENCH | TURBULENT FLOW IN CHANNELS |
| 1938 | N. GOPAL AND | SOME EXPERIMENTS ON SEEPAGE LOSSES IN IRRIGATION |
| 1940 | PANDIT K.R. | THEORY AND PHYSICS OF SEEPAGE FLOW FROM CANALS. |
| 1940 | A.R. THOMAS | FLOW IN EXPANSION IN OPEN CHANNELS. |
| 1940 | PANDIT K.R. | IMPROVED ADJUSTABLE PROPORTIONAL MODULES AND |
| 1941 | A.N. WILSON | CONTROL OF FLOW ON CURVES IN OPEN CHANNELS. |
| 1941 | H.L. VADERA AND | THE KAROL TUBE WELLS SCHEME. |
| 1941 | ISHWAR DAS | HYDRAULICS OF IRRIGATION CHANNELS. |
| 1942 | N.K. BOSE AND | DESIGN OF CHANNELS IN ALLUVIUM. |
| 1942 | DR. V.I. | EFFECT OF CAPILLARITY ON DRAINAGE IN WATER- |
| 1943 | H.R. STEWART | WATER REQUIREMENTS OF CROPS. |
| 1944 | S.I. MAHBUB AND | IRRIGATION OUTLETS. |
| 1947 | GEOGRAPHICAL | INDIA / PAKISTAN BOUNDARIES FIXED BY THE BOUNDARY |



🟩 Punjab Engineer's Congress Archive
🟥 India Office Records (British Library) Archive
🟥 Royal Geographic Society
⬛ Archive.org 🟦 Inst. Civil Engineers

# Fever:Fervour

Attitudes towards the archival

*You know perfectly well that despite the infinite heaps of things they recorded, the notes and traces that these people left behind, is in fact, practictally nothing at all. There is the great brown, slow moving strandless river of Everything, and then there is its tiny flotsam that has ended up in the record office you are working in. Your craft is to conjure a social system from a nutmeg grater, and your competence in that was established long ago. Your anxiety is more precise and more prosaic. It's about PT S2/1/1, which only arrived from the stacks that afternoon, which is enormous, and which you will never get through tomorrow.*
→ Steedman, 2001, 1165

*The Indian Service of engineers in which the British and their Indian colleagues laboured for so many years has passed away, [but] the tradition remains and is a living force [...] The irrigation works of India and Pakistan, down to the smallest distributary channel and the loneliest canal inspection house must always remain a monument to the unknown engineer*
→ Lacey, 1948

*As no one is more aware than himself that the best, if not the only, warrant for his existence is his useful-ness, such circumstances are very distressing. The martyr's hope is sometimes his only consolation--that there is surely a better, time about to dawn, when knowledge will prevail among the people.*
→ Medlicott, The geological survey, 1877, V

Access to the archive both enables and limits understanding. Through this project I have been attuned to the problems of a textual-first approach, and through conceptualising the archival strata [Derrida, 1995] and the geological strata as having a relationship which can contribute to Yusoff's call for an 'Epochal Aesthetics' [2017] That I have moved through the textual representation without mistaking the map for the territory.

But the material stored in London, which I can access with such ease, has long been recognised as powerful. Herbert [2022] Identifies a protracted history of British officials obscuring, destroying and obfuscating swathes of the archival substrate as part of "Operation Legacy". Whether through deliberate destruction or spatial remove, the archival is a 'missing substrate' for critiquing the ongoing colonial infrastrcture of the Punjab. Lacey's rhetorical monumentalising of him and his British colleagues upon their departure speaks to a paternal arrogance of a "job well done" as if through proportional outlets the canal system would operate autonomously, but also illuminates this dislocation. Pierre Nora's concept of Lieu De Memoire / Site of Memory argues that monuments are a site of collective memory. Nora defines Sites of Memory as: *Any significant phenomenon, materialized or intangible in nature, which [...] has acquired the meaning of a symbol in the memorial heritage of a community.* [Nosova, 2021, 217]

Monumentalising also however means that a sterilised, streamlined account of history is conveyed. If the Canal infrastructure of the Punjab stands as 'monuments' to the unknown engineer, then the geneological history that produced the outlet, etc, is silenced.

As shown in the previous chapter, the desiderata and designs of engineers has gone on to create disposition within the hydrological system that exacerbates environmental struggle. Privation of access to the archival, and the geneologies of design, create monuments that produce harm.

It's also ironic to wax lyrical on the unknown engineer when Lacey's and his peers so frequently named their work after themselves. Navigating the archival resembles the tortuous attenuation of liquid through soil, where an assumed order stands in discrepancy to the labyrinthine search for information.

Derrida's 1995 Text Archive Fever asks what is the place of the archive in relation to holding power and authority. [Derrida, 1995]. Exploring the etymological paleochannels that have shaped the present meaning of archive, he shows how the archive is both a domicile (arkheion) but also a site of commandment (arkhe). He argues that who cares for the archive are empowered, and further that their authority is reliant on the "substrate" of material deposits that constitute the archive's objects. Thinking through this, the textual substrate of the archive can be seen through Sedimentary Desiderata to have commanded power over the substrates of the Punjab, which in turn record the design rationalities through their geomorphology.

But if the authority of the archive is derived from its substrate, an accrual, a sedimentation of textual deposits, then a de-sedimentation of this material is a transformative act.

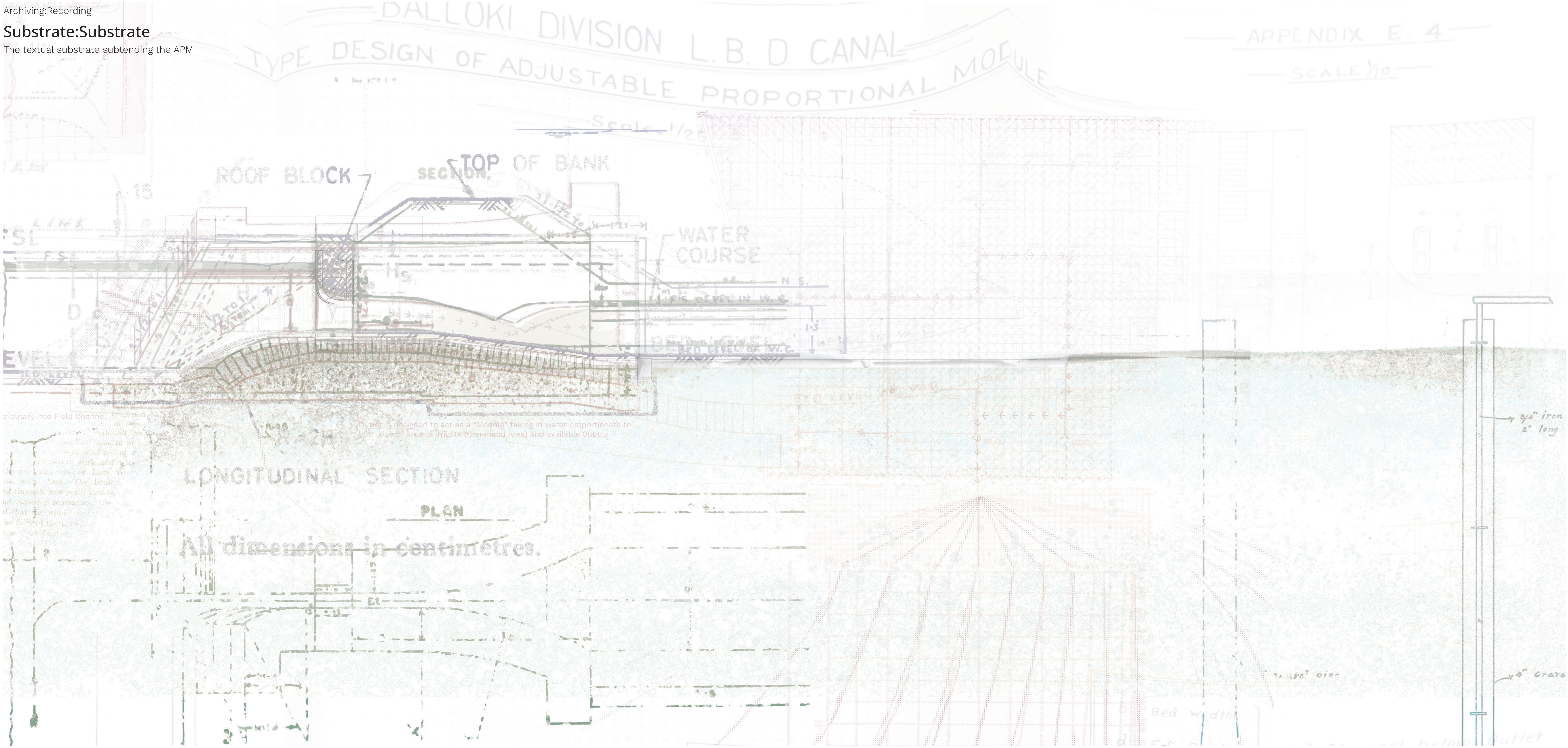
Intervening in the archive has been explored by several projects which I have drew inspiration from.With the widespread use of the internet, counter-archives have also developed. These are outlined overleaf.

Screenshot of my camera roll from the British Library

Archiving:Recording

## Substrate:Substrate

The textual substrate subtending the APM

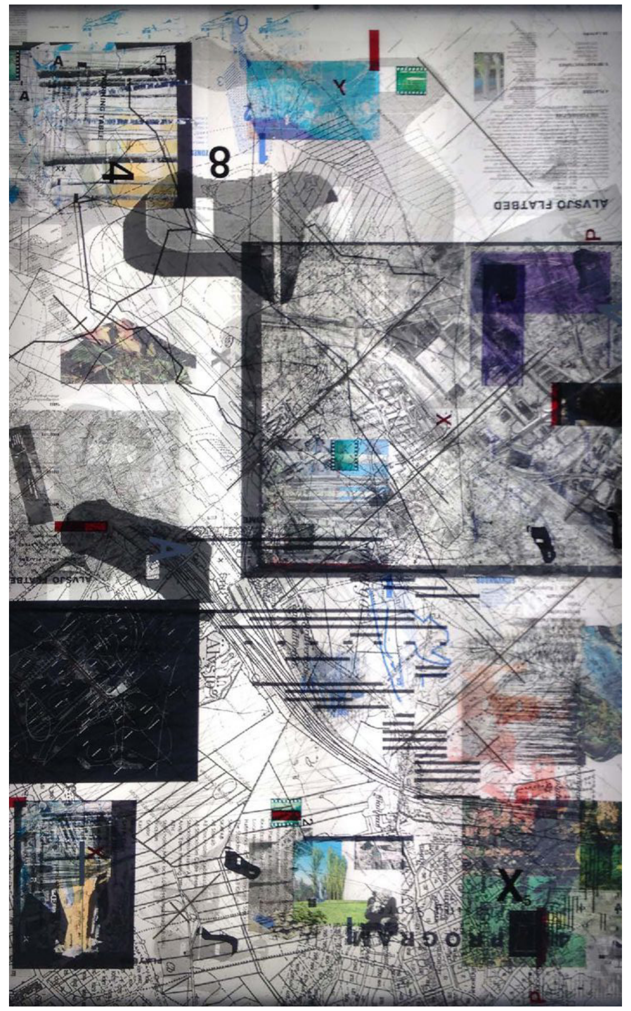

BALLOKI DIVISION L. B. D. CANAL
TYPE DESIGN OF ADJUSTABLE PROPORTIONAL MODULE
APPENDIX E 4
SCALE 1/10
Scale 1/25
ROOF BLOCK
TOP OF BANK
SECTION
WATER COURSE
F.S. LEVEL IN W.C.
BED LEVEL OF W.C.
N.S.
F.S.L.
LEVEL
Hs
tributary into Field Channel
Outlet is designed to act as a "Module" taking in water proportionate to both size of area to irrigate (Command Area) and available Supply
R = 2H
LONGITUDINAL SECTION
PLAN
All dimensions in centimetres.
3/4" iron 2" long
4" Grave
Bed width

# Arkheion:Arkhe

Precedents of de-sedimenting the archive

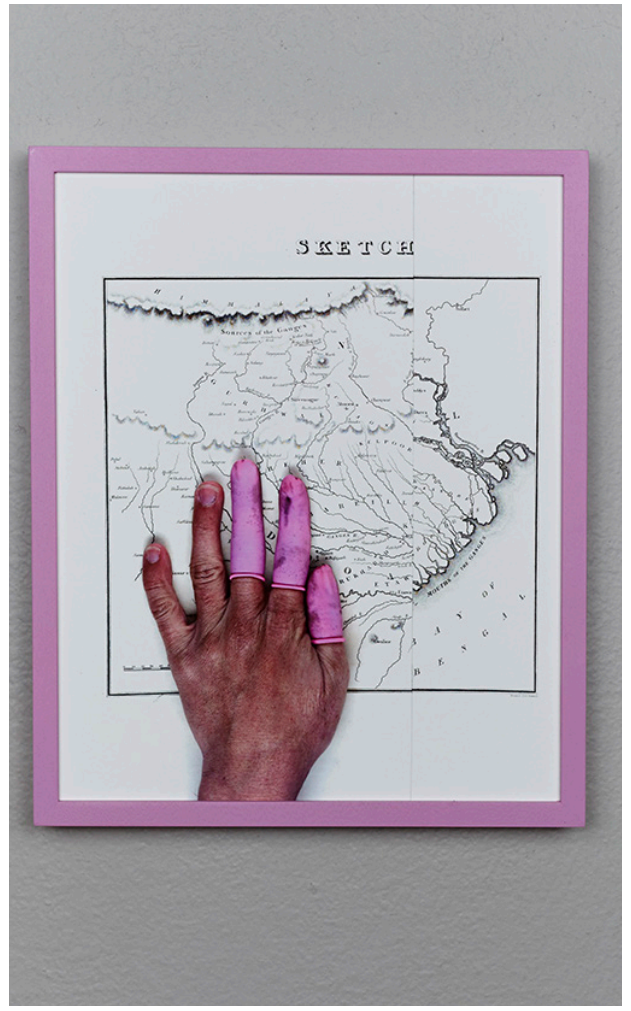
**The Portuguese (Re)Constitution**

Collective publication collaging and engaging with the textual substratum of Portugal's former autocratic regime



**Alvsjo Flatbed, James Corner Field Operations**

Collage of found material visually united through a lightbox. Mapping out different elements that a resultant design should address

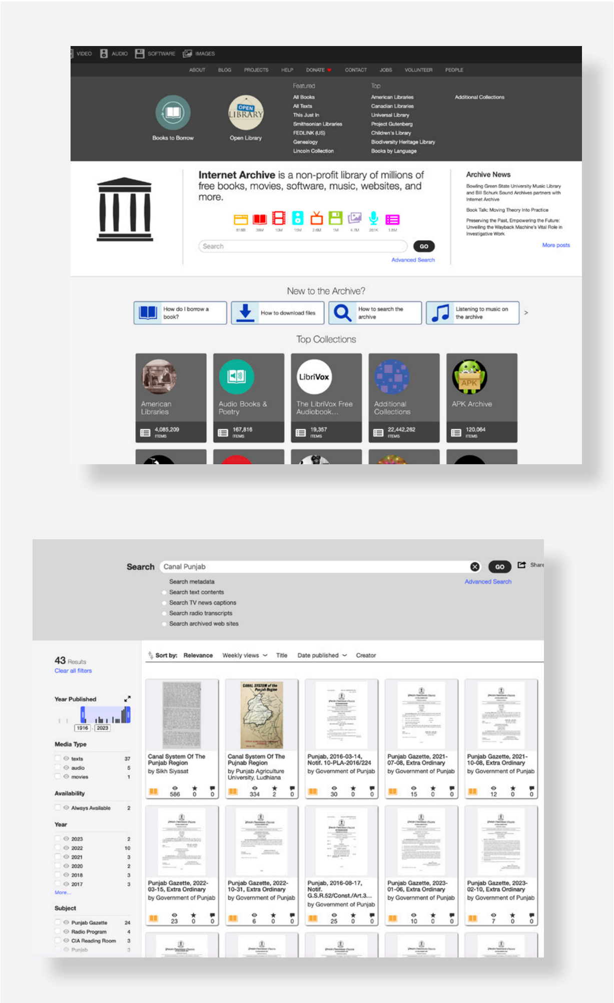


**ScanOps**

Project based on accidents in the scanning of Google Books, highlighting the labour involved.

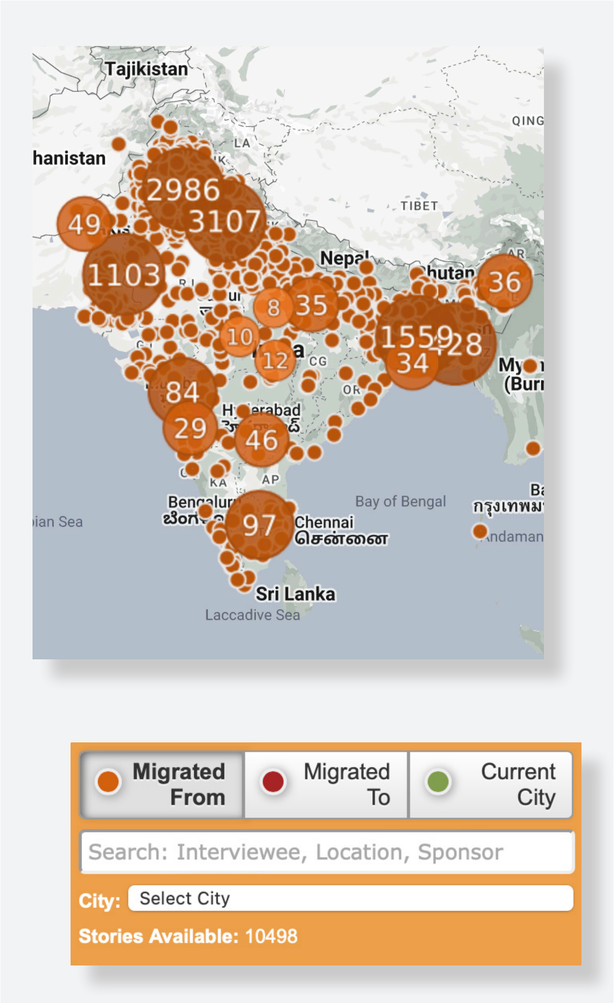
# Arkheion:Arkhe

Alternative Archives



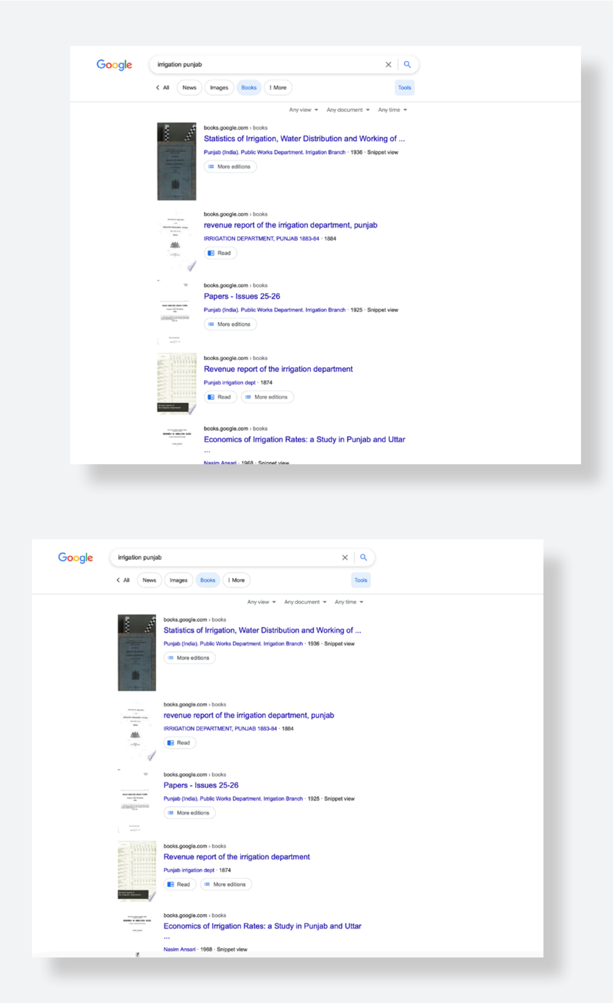
**Archive.org**

Founded 1996. Non-profit archive project digitising out-of-copyright material, websites (Wayback Machine), and most media formats. Allows users to readily upload material.


Tajikistan
hanistan
TIBET
Nepal
hutan
Bay of Bengal
Sri Lanka
Laccadive Sea
Chennai
Bengaluru
2986
3107
49
1103
8
35
10
12
1559
28
34
36
84
29
46
97
Migrated From
Migrated To
Current City
Search: Interviewee, Location, Sponsor
City:
Select City
Stories Available: 10498

**1947Partition Archive.org**

Founded 2008. Crowdsourced and geo-located testimonies from people displaced by the partition of India and Pakistan Allows digital submission, as well as crowdsourced digitisation of analogue accounts.

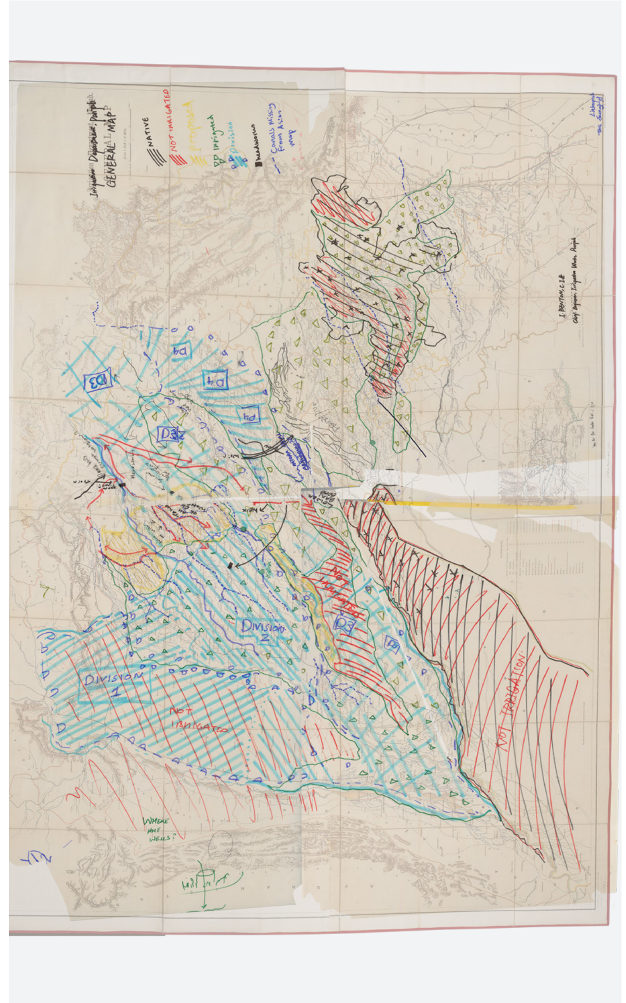


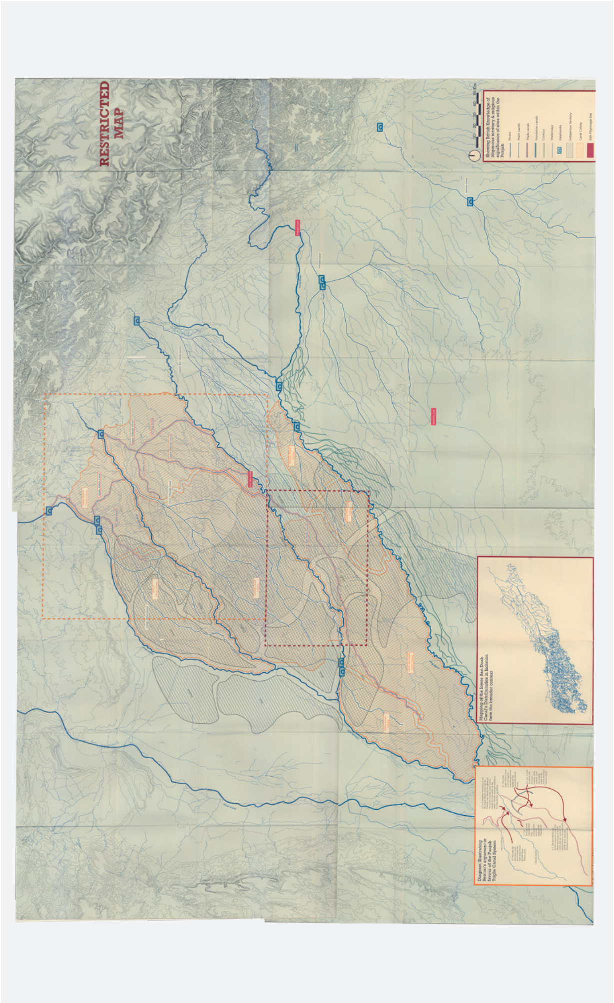
**Books.Google.com**

Established 2002. Search functionality for books digitised and text-recognised by Google. Limited view of copyrighted material.

# Archival:Pedagogical

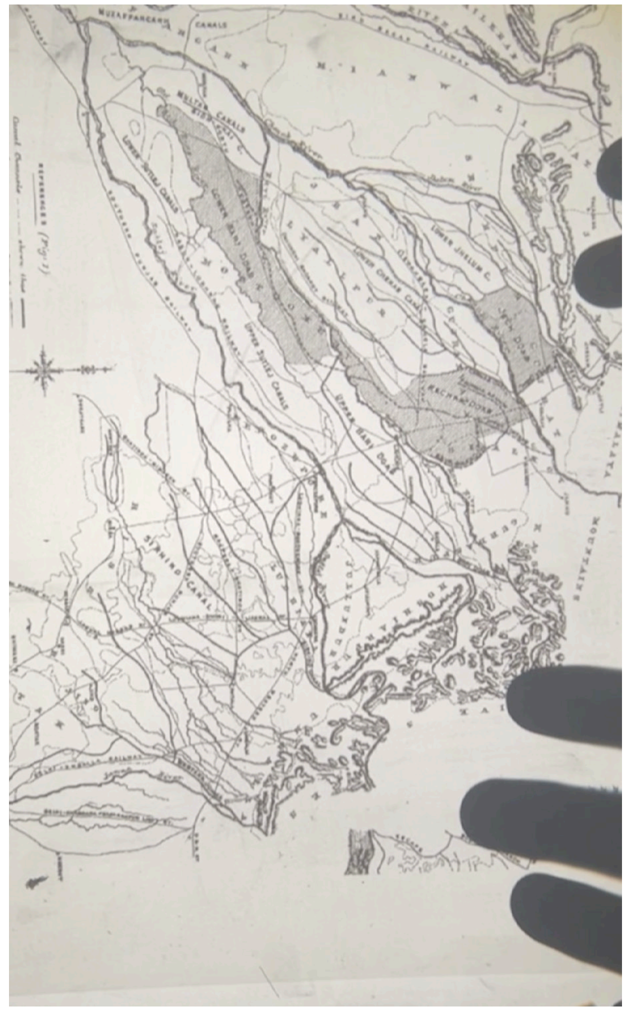
Developing Attemps to desediment the archive



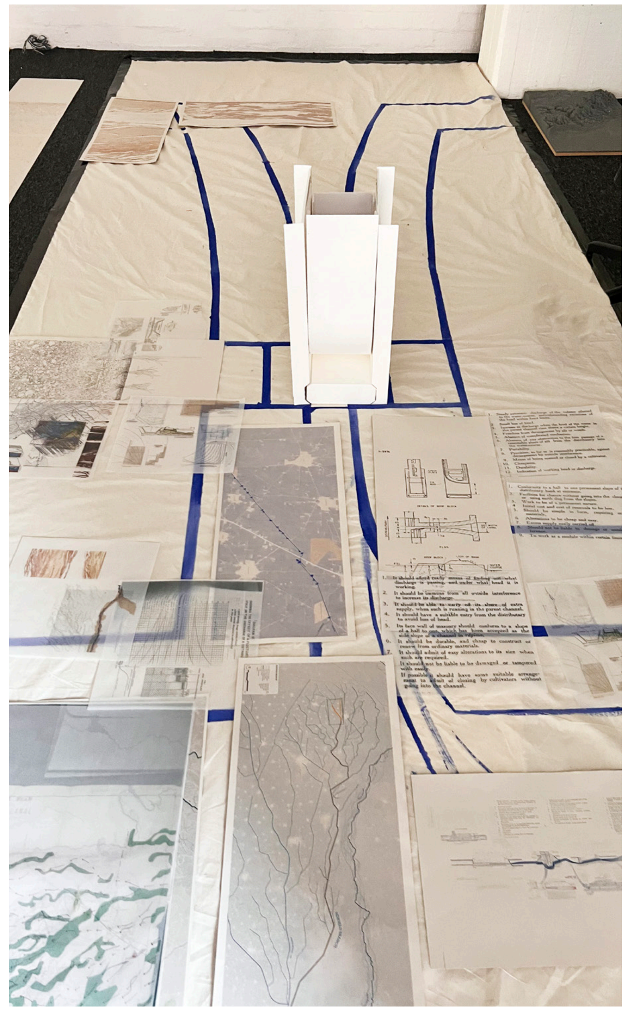


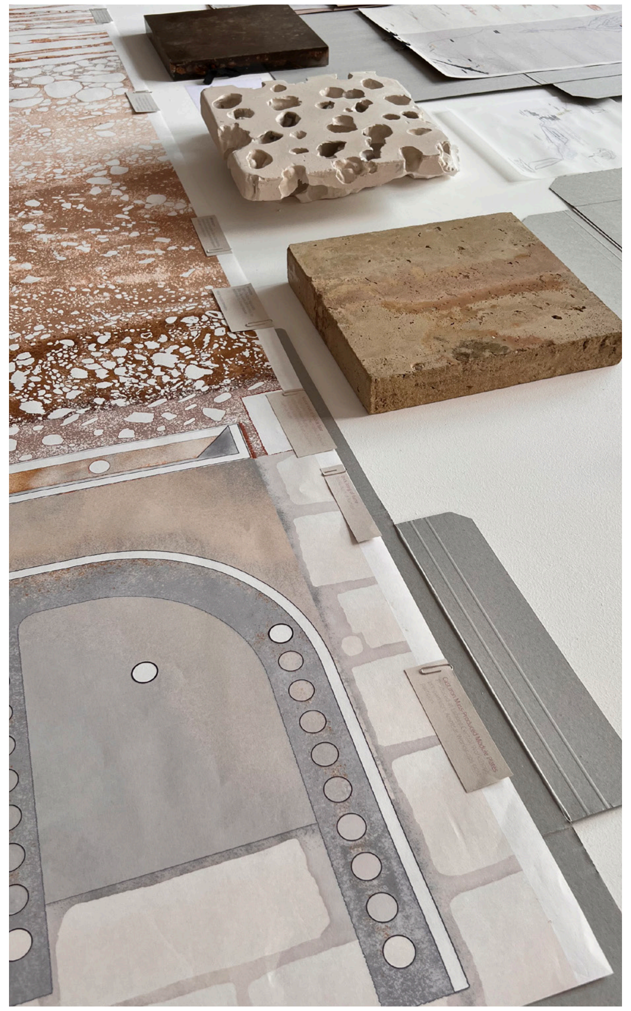
In Term 1, "Unmapping the Punjab Triple Canal Project" responded to Benton's original map in kind; we produced a counter map which challenged Benton's original text and map (centre).

The most enduring work from this project was the collective drawing (left). A detailed look at the map - its lines, text and what they signify - juxtaposed against open source digital mapping opened up understanding of how instrumental / institutional practice translated to on the ground impact. This spirit has carried forward into Sedimentary Desiderata.



In Term 2 when working on a group documentary "Reliance and Resilience" I juxtaposed archival material and my analysis through the shared medium of overhead projectors, a presentation tool that evokes analogue slide shows. However this brought me further away from the archival material itself and did not facilitate a meaningful look at how and why documents were produced.





In developing the outcome of Sedimentary Desiderata, my initial planned output was to create a video summarising my research process. However, in studio discussions it became clear that, as this project is grounded in institutional critique, I needed to push critique of my own practice further. We discussed the need to work outside of comfort zone and the potential that this can achieve. I instead leaned into a de-sedimented approach, producing representations that were diverse in form, media, and style but rooted in their scalar relationships. In presentations, I used 1:1 scale representations of the outlet as anchor points to curate my work around, laying down analytical drawings and developing links in enquiry/claims through the placement of collage.

For the exhibition I retained the paper sizes and their scalar link to the outlet while pushing this scale further by modelling the canal system against this scale, Juxtaposing an individual outlet against the entire canal system. These models, composed from paper mache of recycled archival material, were laid out among the paper work, with a 1;1 drawing of an outlet and subsoil laid across the length of the table.

# Deposit:Desediment

Methods of intervening in the archive

*Our collections include over 170 million items from almost every language and faith group. Together, they occupy over 746km of total shelving – equivalent to the distance from London to Aberdeen, and this is growing an extra 8km every year. [...] In our collections you can find:*
*Material ranging from Magna Carta and Leonardo da Vinci's Notebook to today's newspapers and websites*
*13.5 million printed books and e-books*
*310,000 manuscript volumes: from Jane Austen to James Joyce; Handel to the Beatles*
*60 million patents*
*60 million newspapers*
*Over 4 million maps*
*Over 260,000 journal titles, many of them digital*
*7 million sound recordings from 19th-century wax cylinders to CDs and radio broadcasts*
*8 million stamps*
*over 500 terabytes of preserved data in our UK Web Archive which, since 2013, has aimed to collect every UK website.*
→ Facts and Figures of the British Library, Bl.uk

*The Internet Archive serves millions of people each day and is one of the top 300 web sites in the world. A single copy of the Internet Archive library collection occupies 99+ Petabytes of server space (and we store at least 2 copies of everything). We are funded through donations, grants, and by providing web archiving and book digitization services for our partners. As with most libraries we value the privacy of our patrons, so we avoid keeping the IP (Internet Protocol) addresses of our readers and offer our site in https (secure) protocol.*
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Where the Raj and East India Company's archive has been fought over legal grounds, the textual substrates of post independent former colonies is a story of deliberate destruction, obscurement and obfuscation. Herbert [2019] shows, through ongoing battles over the textual record from the Mau Mau massacre to Windrush, that "the British empire never ended" as control and of information continues to have legal, mnemonic and social consequences. If the archial substrate remains deposited in the British Library of London, then the colonial knowledge-production-storage dynamic remains stilted.

To desediment the archival is to intervene in this "settled state" it is to show that the textual substrate oc the archive and its derived power is cemented by historical forces whose present stasis has accrued from out of historically thwarted struggle and resultant inertia with the way things are.

Caroline Steedman, taking Derrida's title and flipping Fever from a Freudian illness to mean feverish obsession that a historian encounters with the archive. The insurmountable stream of information. The fact that 'they left everything'. Steedman points to the fuller picture of the archival; that it houses ket documents, legislation, technical papers, but also that the act of archiving is itself feverish [Steedman, 2002].

The reticence of the UK government to consider any return to the India Office Records is reflected in its feverish archiving of material through the British Library. Under the legal deposit act, 2003, any text published within the UK (including self published work) must have a copy deposited with the British Library.

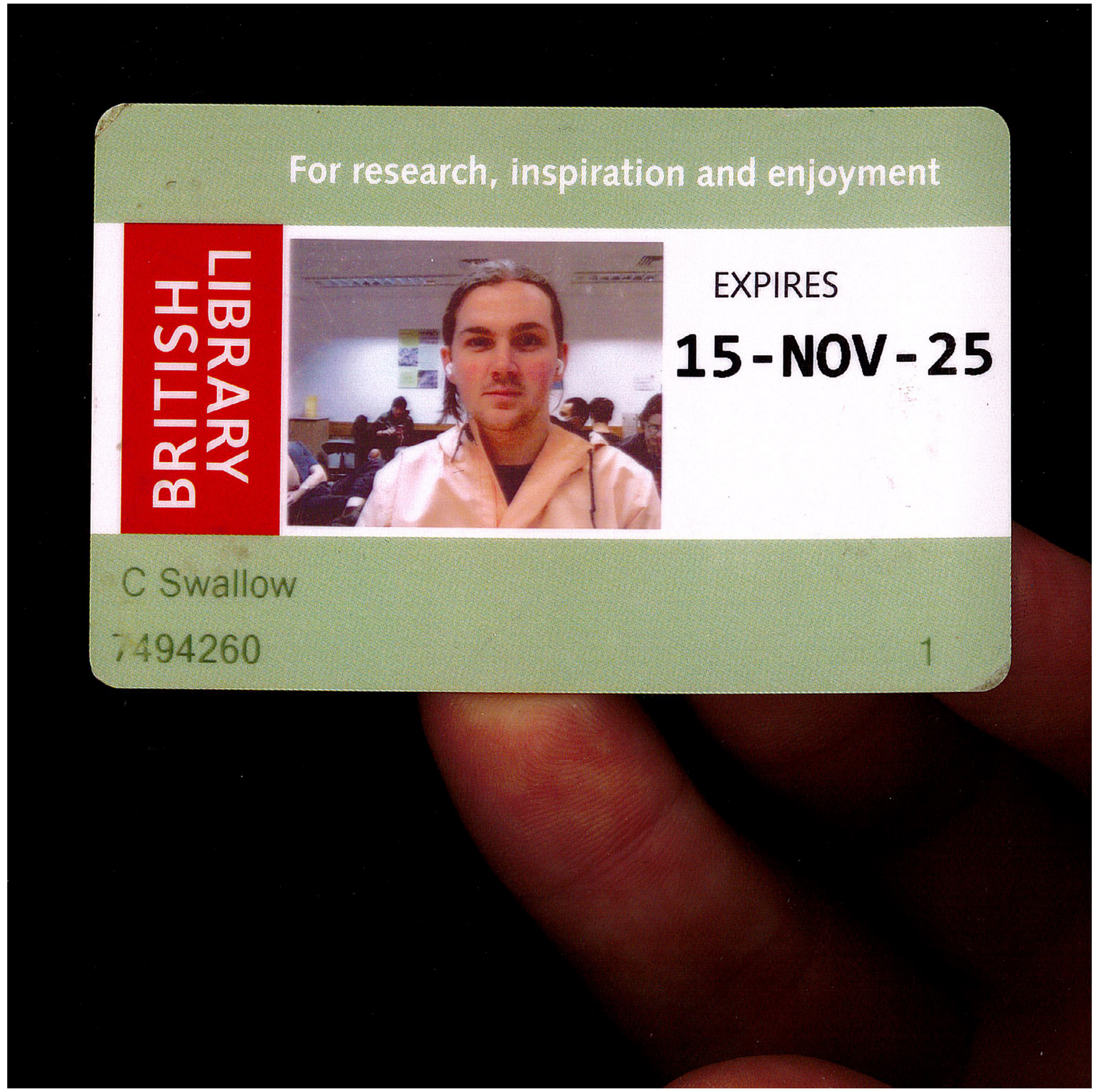
The BL specifies that:
*Print publications for legal deposit can be books, journals, sheet music, maps, plans, charts or tables. Now legal deposit also covers material published digitally such as websites, blogs, e-journals and CD-ROMs.*

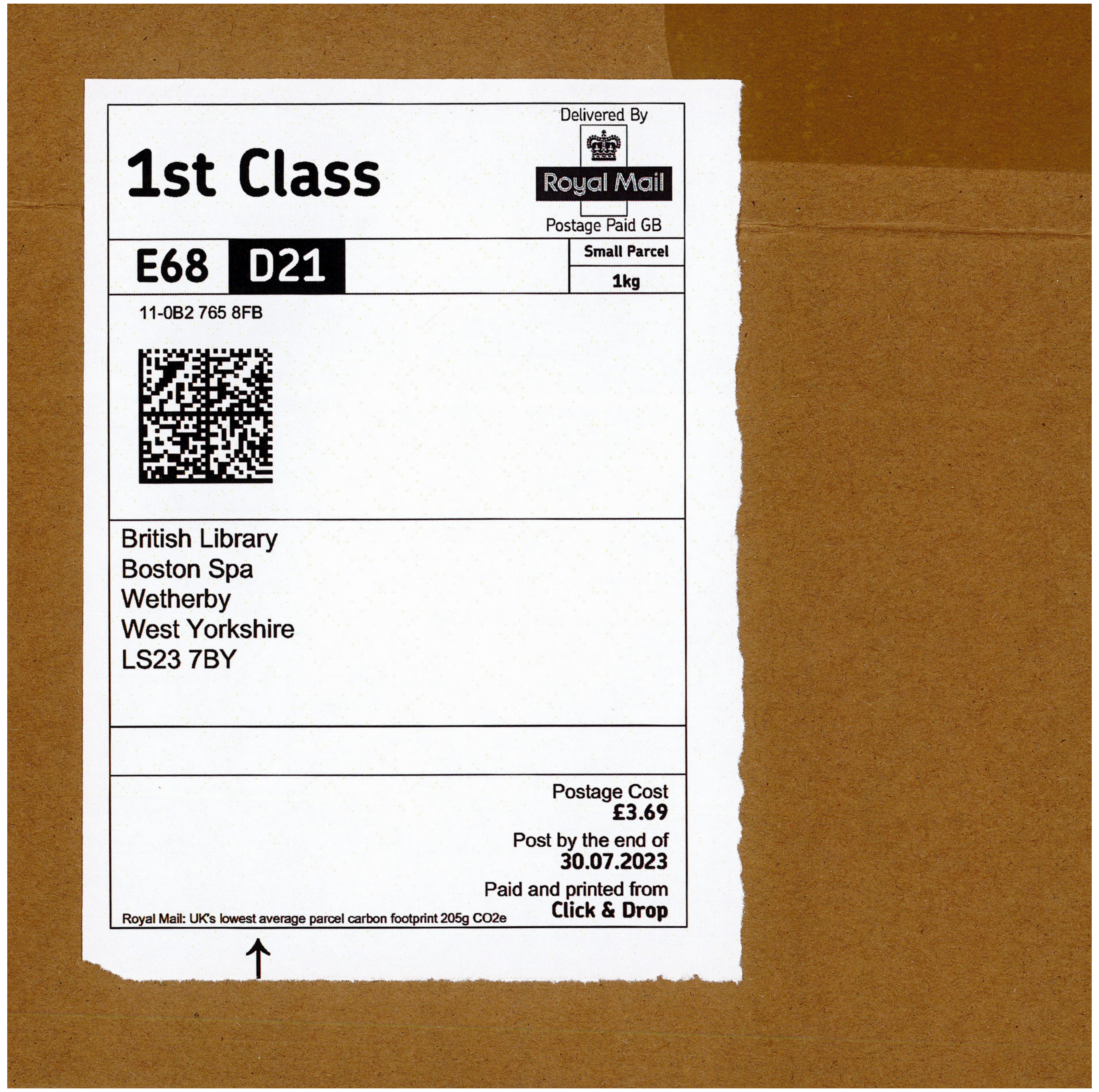
Formalised in 2003 but in force in different permeations since 1662, the legal deposit structure means that the textual substrate is not just a source of authority but inclines towards being the authoritative account of all texts.

Through the legal deposit scheme, the sedimented deposits of the British Library - its (find a superlative) is never cemented but forms a porous body of material that is forever having new deposits accrued and with it different concepts, ideas and relations between the texts attenuate through.

Through adherance to the Legal Deposit scheme (a lot of self/private publications do not) offers a route to de-sediment the India Office Records and the British Library's archive. I therefore decided to intervene in the archival substrates through the Legal Deposit Scheme (this process is outlined in the proceeding pages)

However, an intervention within the British Library is still spatially bound and limited. Digital archives are actually de-sedimenting the fundamental power structures of the physical archive. The critique of the outlet's design that this project sets out would not be possible from within the India Office Records alone, and required the counter perspectives afforded through the digitised archives of the Punjab Engineer's congress. In recognition of this, I have also uploaded all work from this project to Archive.Org, the open source archive website wherein any user can download my work.





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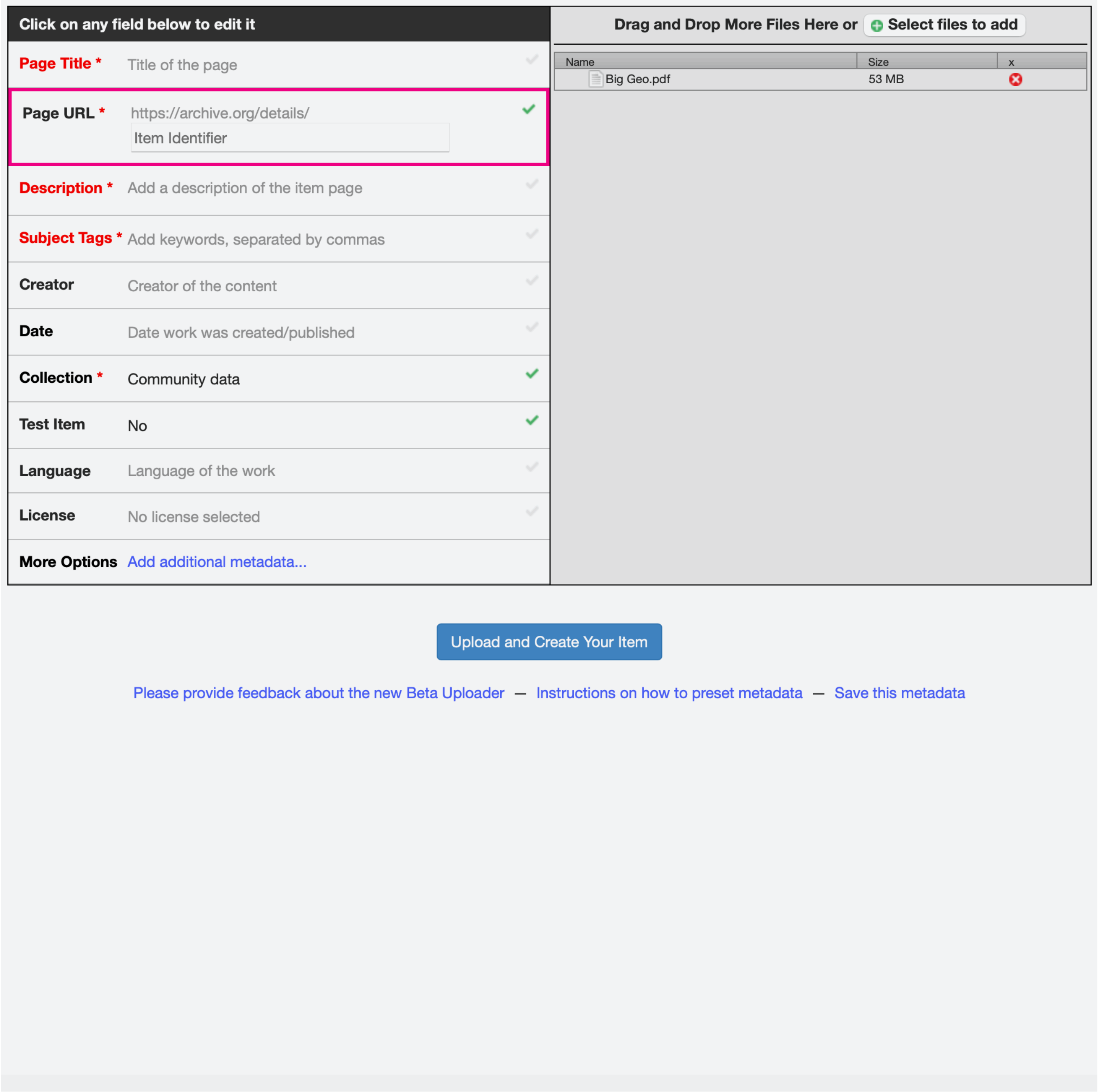

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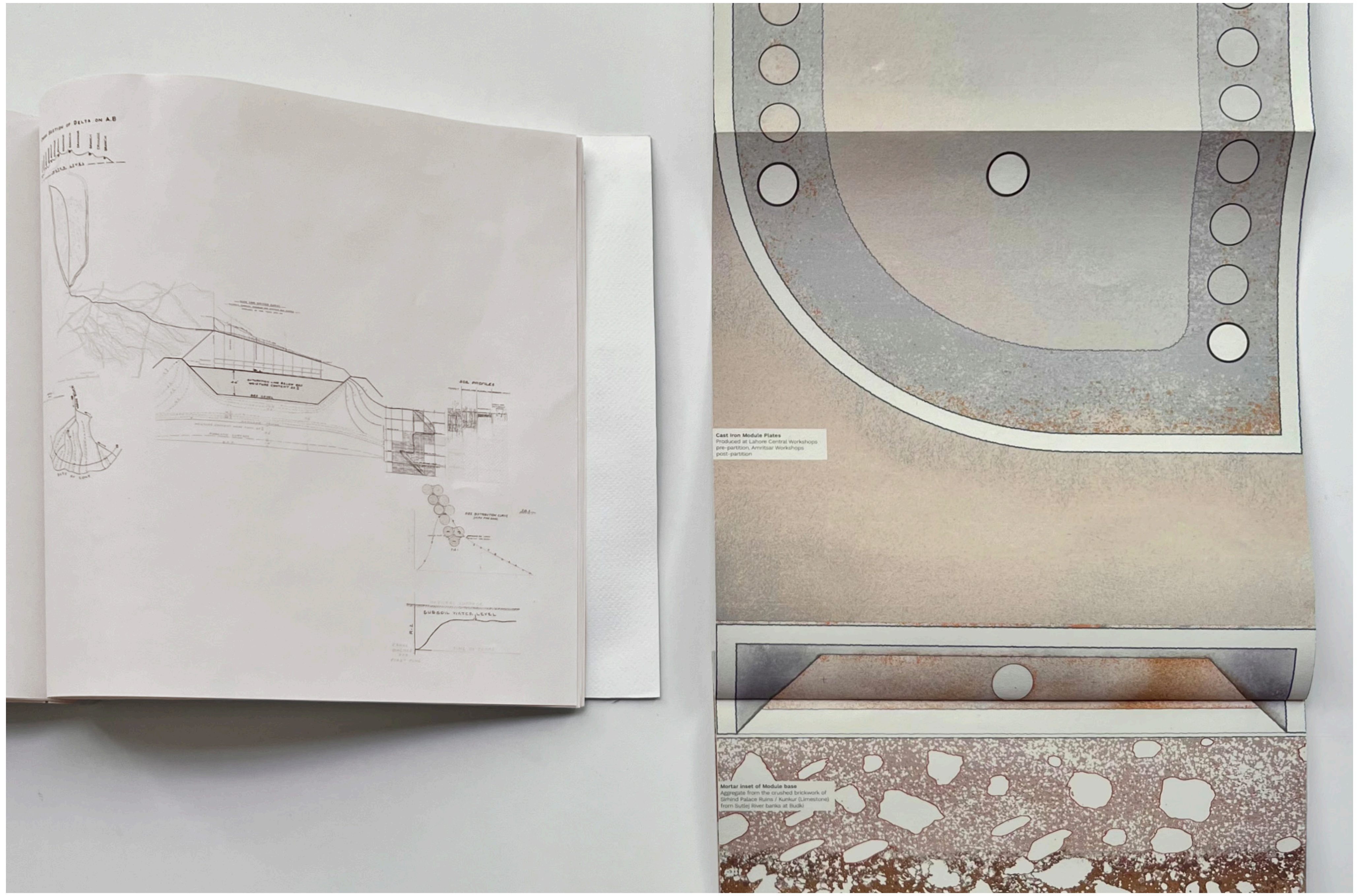
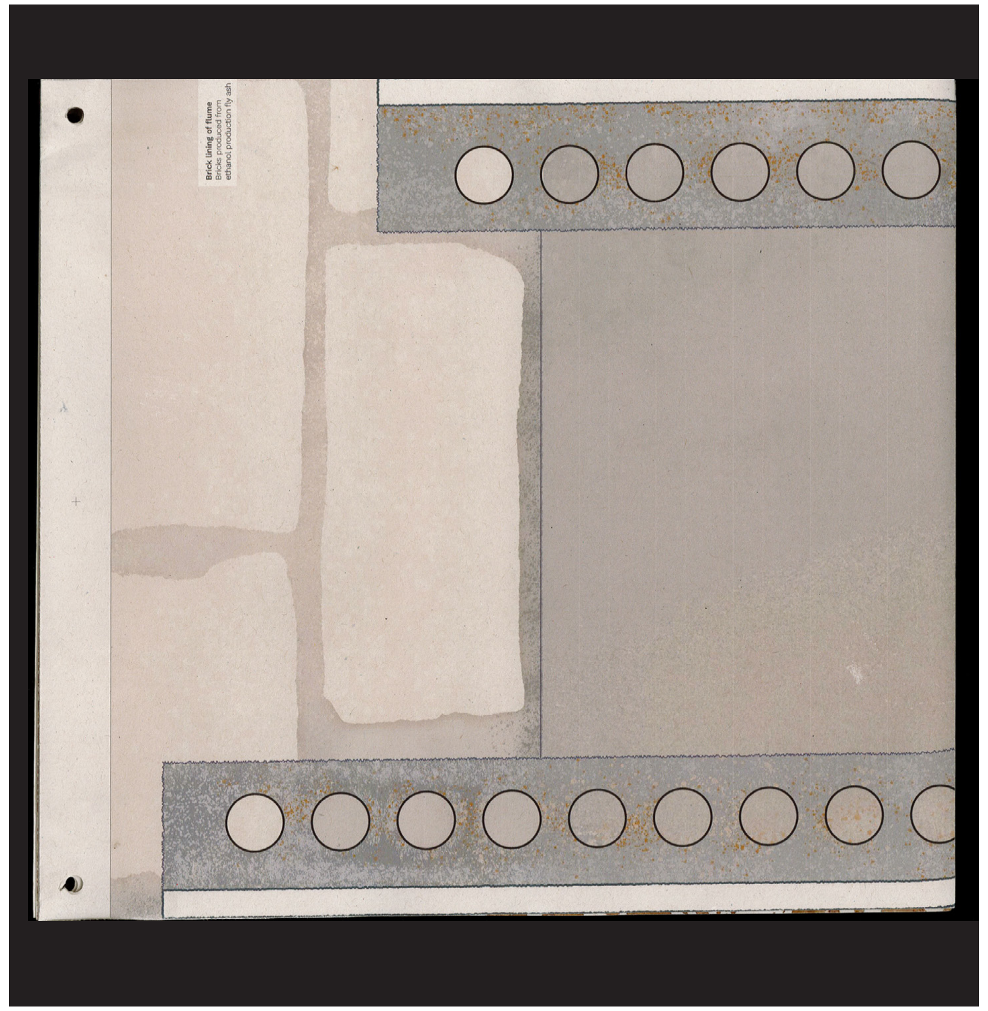
Methods of Depositing: Postal details for submitting a legal deposit to the British Library

Methods of depositing: Uploading to Archive.org

## Finalized Intervention


Cast Iron Module Plates
Produced at Lahore Central Workshops pre-partition, Amritsar Workshops post-partition
Mortar inset of Module base
Aggregate from the crushed brickwork of Sirhind Palace Ruins / Kunkur (Limestone) from Sutlej River banks at Budki

Booklets developed for submitting to the British Library

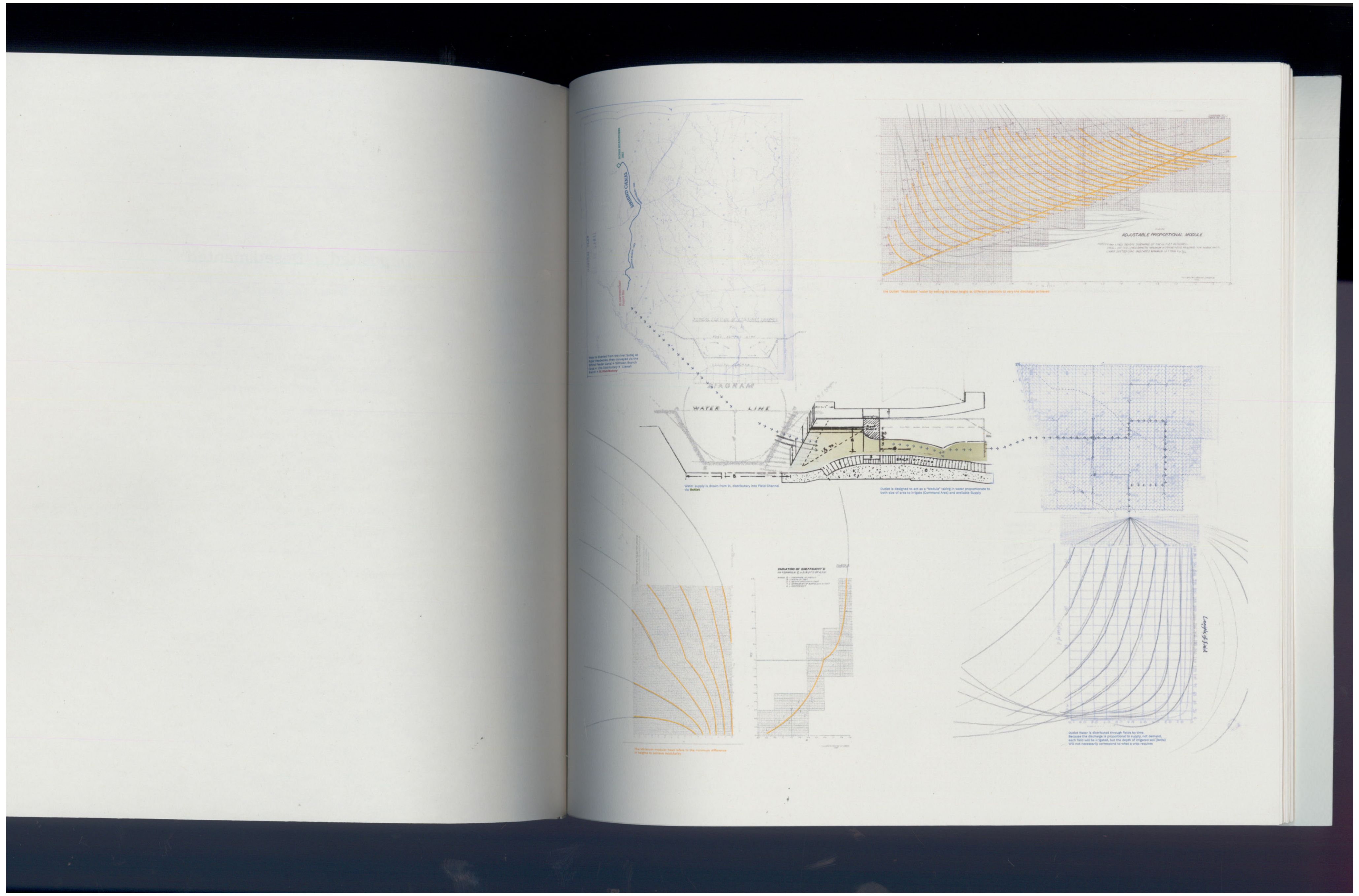


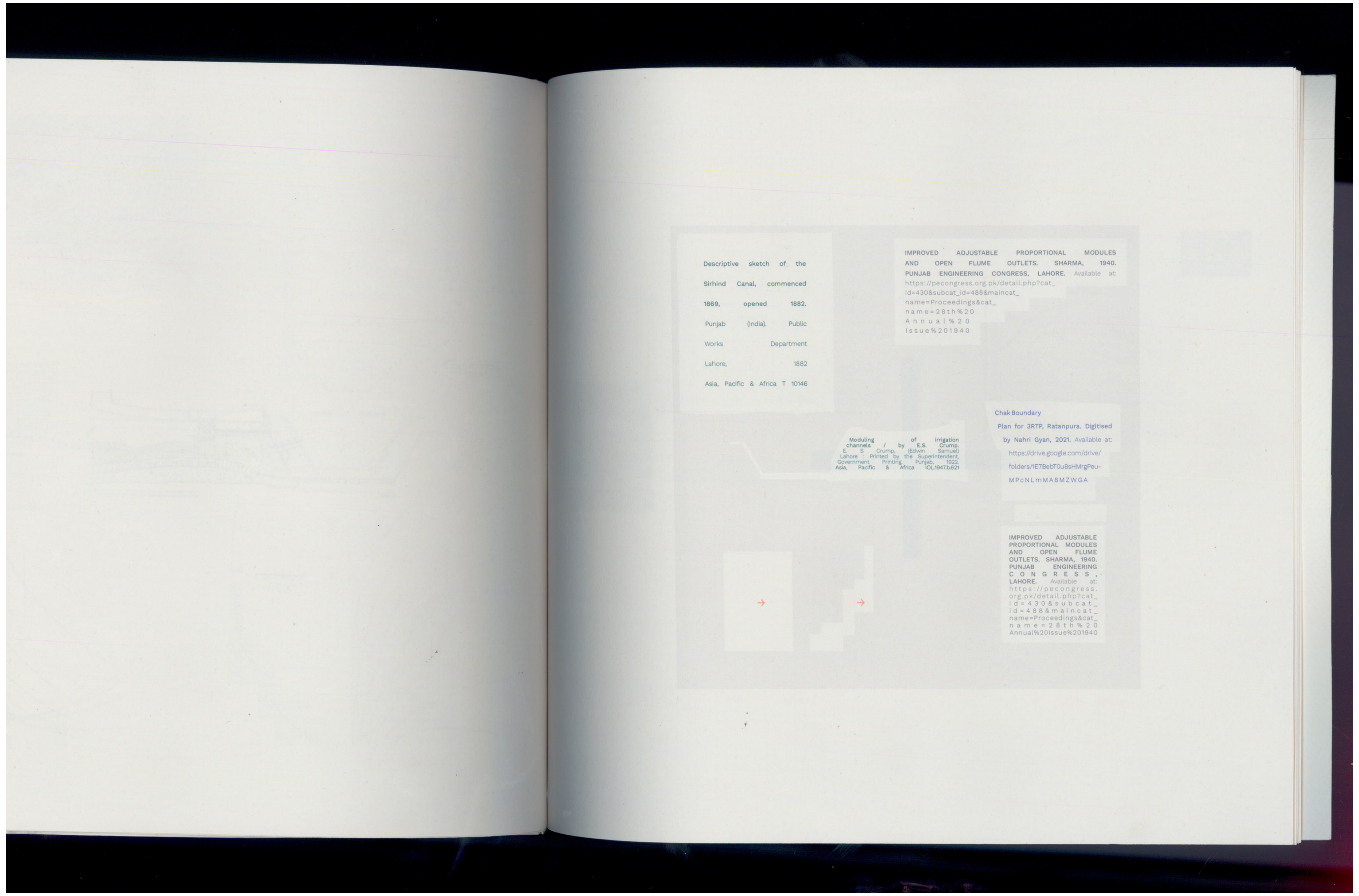
Following the exhibition I had planned to submit the work to the British Library under the legal deposit scheme, as folios of work.

However, in seeing how visitors to the exhibition engaged with these folios, I saw that the problematics of representation previously mentioned - combined with the broader exhibition's tone - produced an alienating effect on viewers. Cognizant of how the archival setting also can have this effect, I decided to submit two bound collections. One of a selection of collages (left) bound in a paper-mache cover, and one of the outlet/soil section, at 1:1 scale.

Between these two works - my loosest, experimental outputs, and my heaviest, most labour and research intensive - I believe that the scope of the project is summarised aptly, as well as both presenting as the beginning of a conversation, not finalised presentations.

Spread layout of Collages and References




Descriptive sketch of the Sirhind Canal, commenced 1869, opened 1882. Punjab (India). Public Works Department Lahore, 1882 Asia, Pacific & Africa T 10146

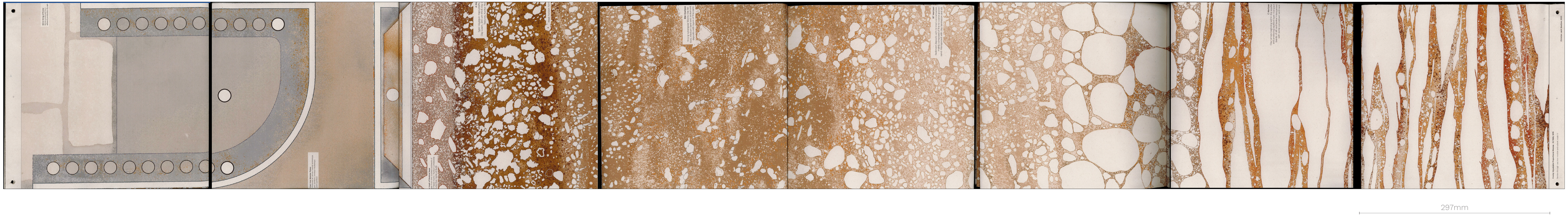
IMPROVED ADJUSTABLE PROPORTIONAL MODULES AND OPEN FLUME OUTLETS. SHARMA, 1940. PUNJAB ENGINEERING CONGRESS, LAHORE. Available at: https://pecongress.org.pk/detail.php?cat_id=430&subcat_id=488&maincat_name=Proceedings&cat_name=28th%20Annual%20Issue%201940

Moduling of irrigation channels / by E.S. Crump. E. S Crump, (Edwin Samuel) Lahore : Printed by the Superintendent, Government Printing, Punjab, 1922. Asia, Pacific & Africa IOL.1947.b.621

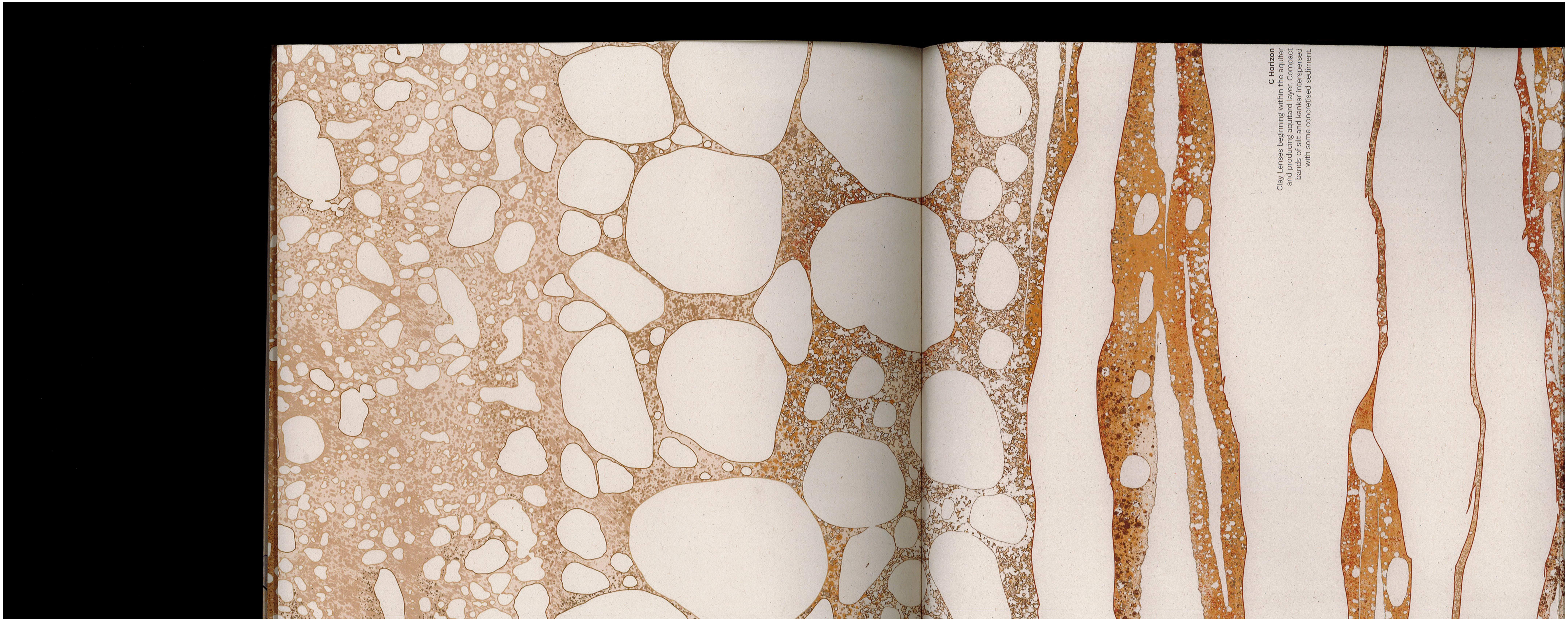
Chak Boundary Plan for 3RTP, Ratanpura. Digitised by Nahri Gyan, 2021. Available at: https://drive.google.com/drive/folders/1E7BebT0u8sHMrgPeu-MPcNLmMA8MZWGA

IMPROVED ADJUSTABLE PROPORTIONAL MODULES AND OPEN FLUME OUTLETS. SHARMA, 1940. PUNJAB ENGINEERING CONGRESS, LAHORE. Available at: https://pecongress.org.pk/detail.php?cat_id=430&subcat_id=488&maincat_name=Proceedings&cat_name=28th%20Annual%20Issue%201940

Left: Example of collage layout
Right: Example of citations. Each collage is met overleaf with a citational key explaining the sources.



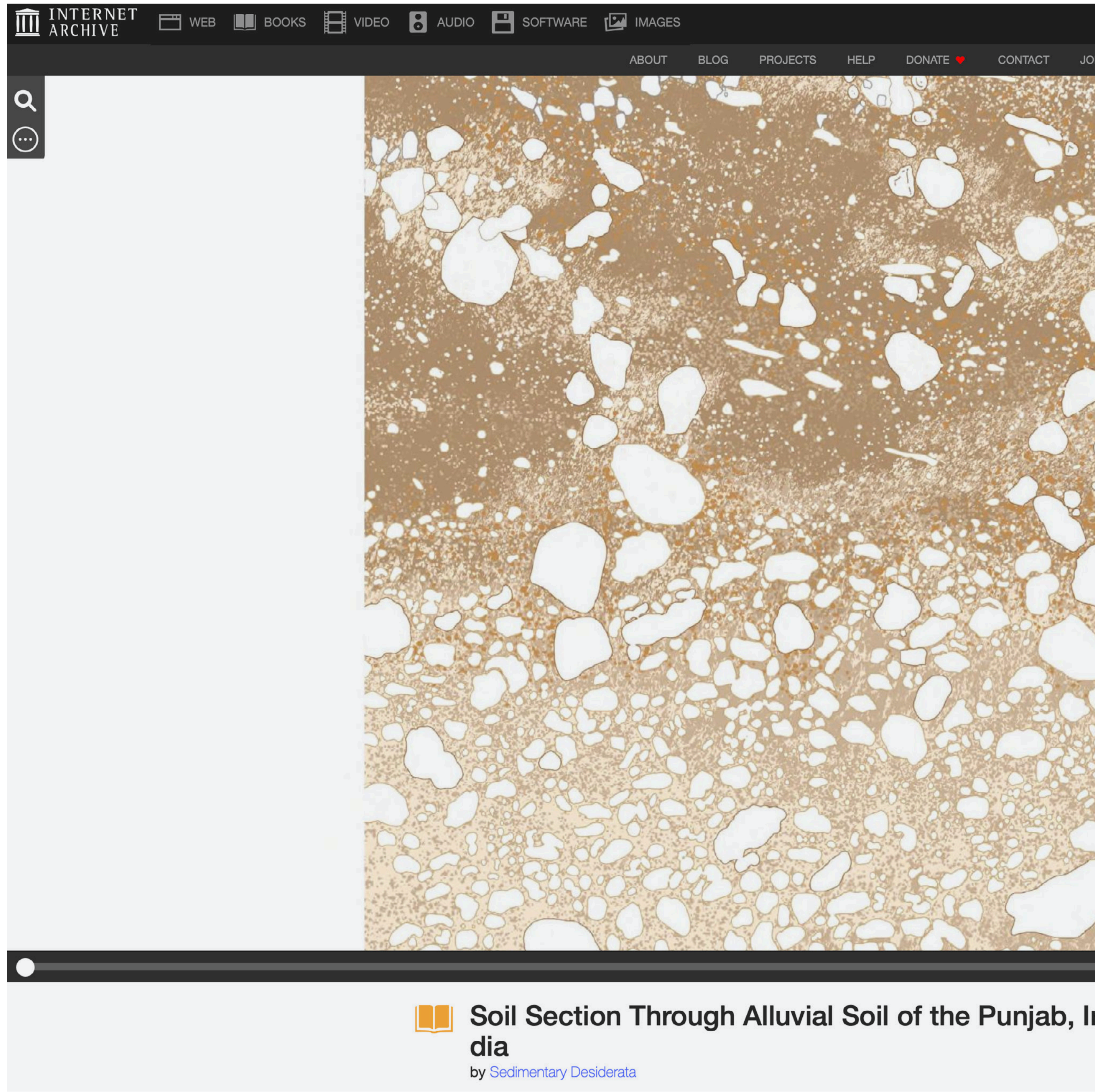
Unfolded outlet book. With the binder screws removed, the book can be unfolded to present the 2.5m deep soil section at 1:1 scale.



**C Horizon**

Clay Lenses beginning within the aquifer and producing aquitard layer. Compact bands of silt and kankar interspersed with some concretised sediment.

Detail of a spread when the drawing remains bound. Image at 1:1 scale with printed book.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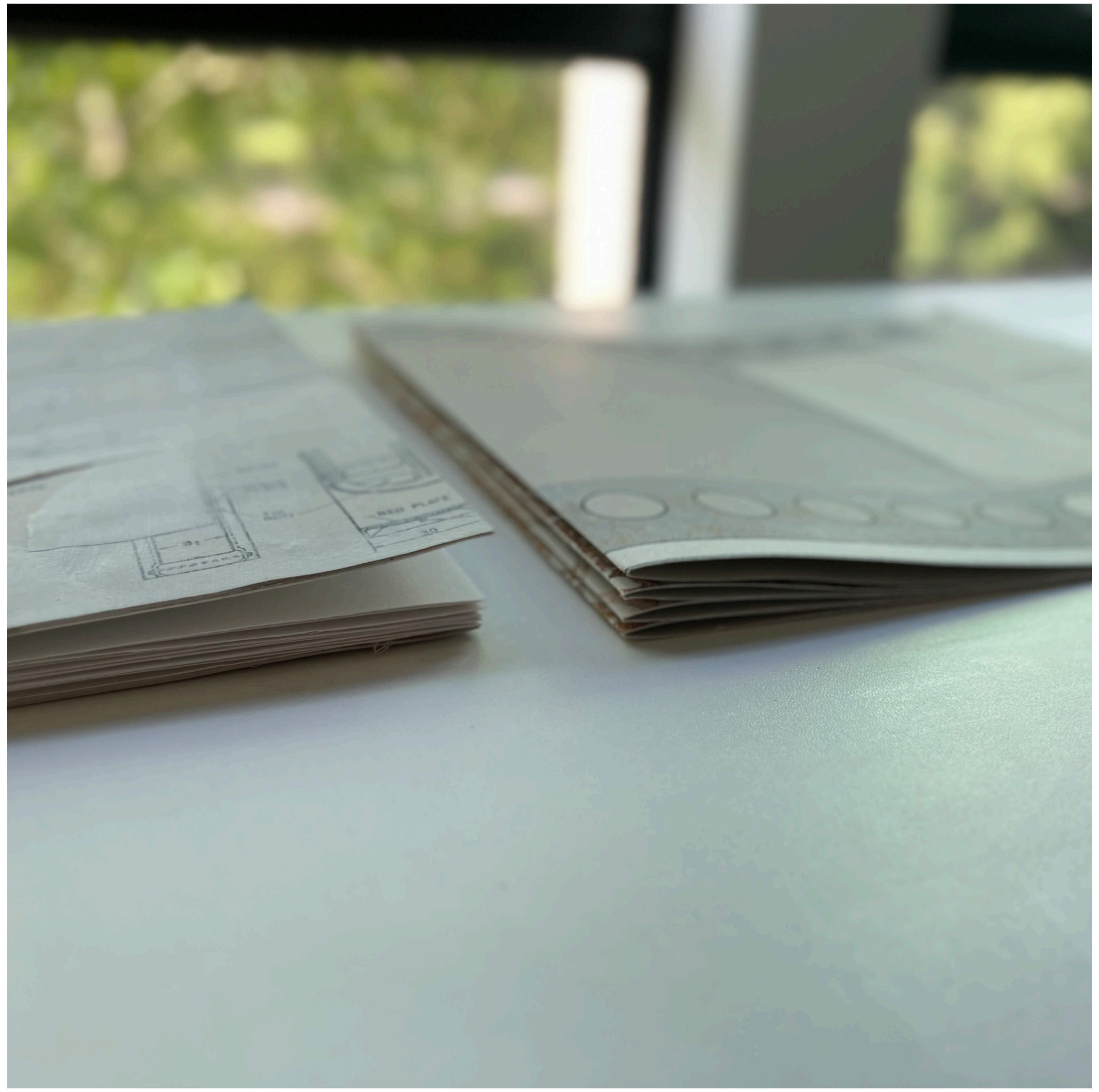
Soil Section Through Alluvial Soil of the Punjab, I
dia

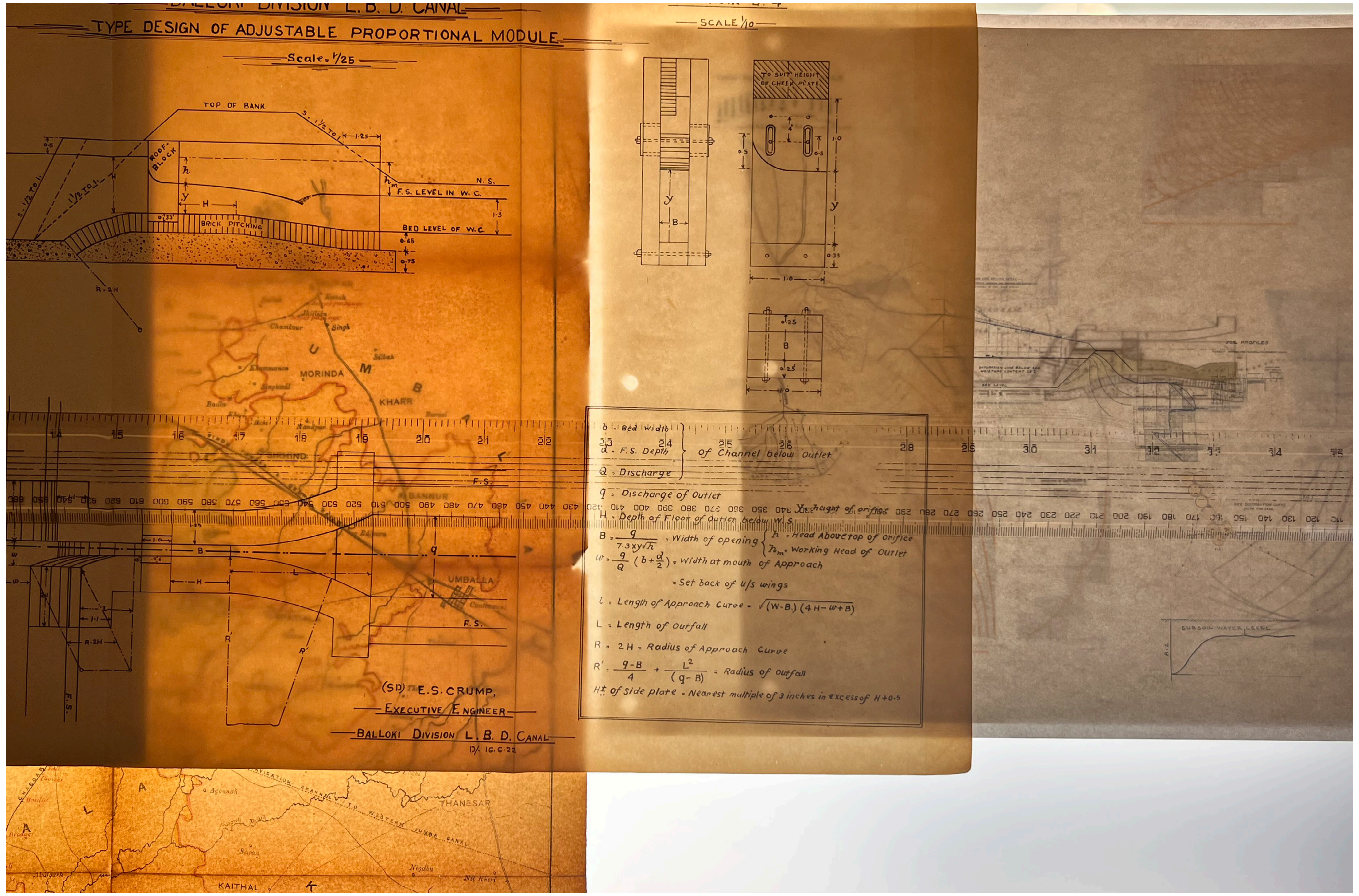
by Sedimentary Desiderata

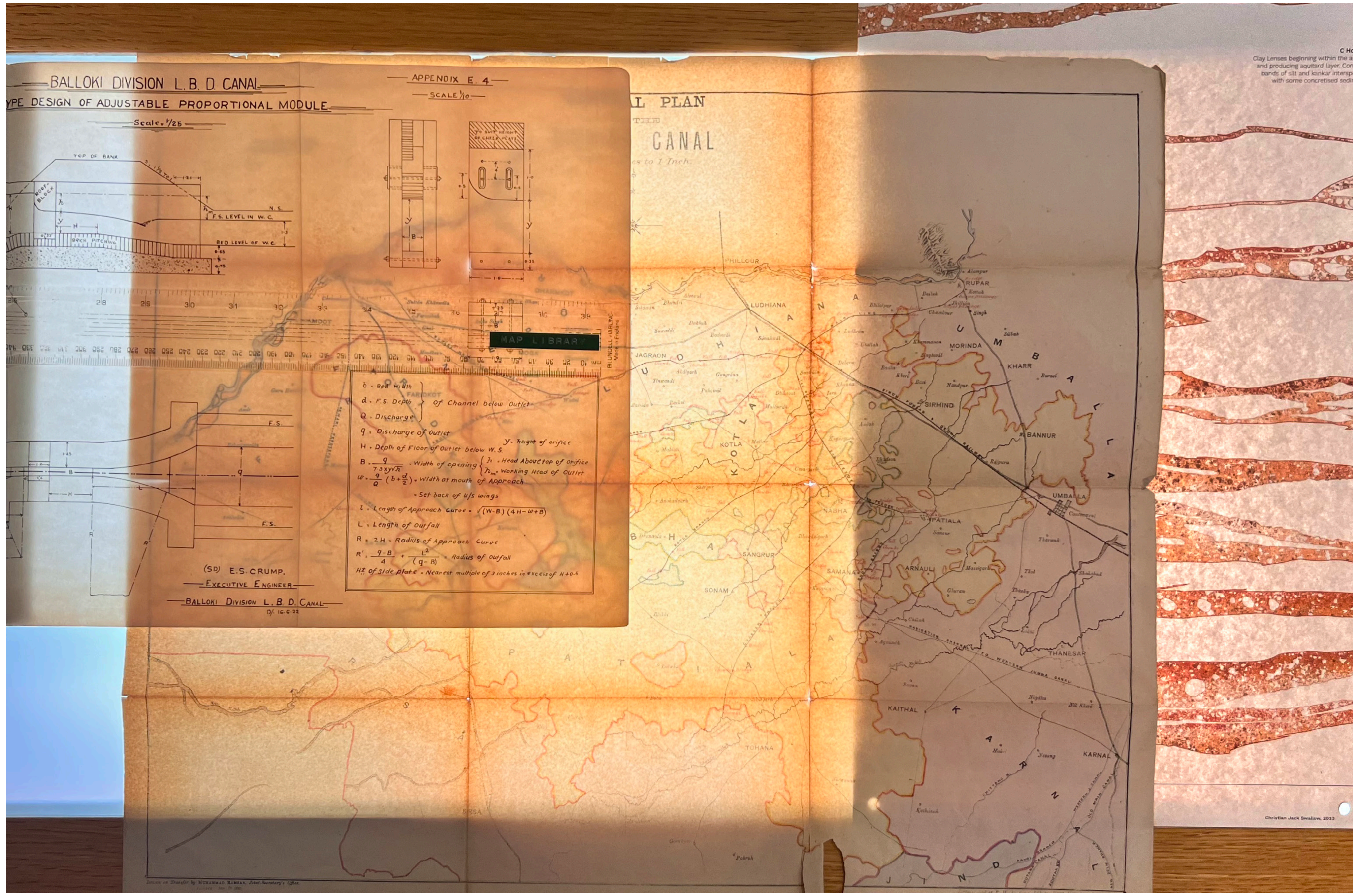
Request Slips for items within the India Office Library, London.

1:1 Drawing of Subsoil unfolded within the British Library



Taken at the British Library. Crump (1922) Paper in view


BALLOKI DIVISION L. B. D. CANAL
TYPE DESIGN OF ADJUSTABLE PROPORTIONAL MODULE
Scale. 1/25
SCALE 1/10
TOP OF BANK
F.S. LEVEL IN W.C.
BED LEVEL OF W.C.
(SD) E.S. CRUMP,
EXECUTIVE ENGINEER
BALLOKI DIVISION L. B. D. CANAL
MORINDA
KHARR
UMBALLA
THANESAR
KAITHAL


BALLOKI DIVISION L. B. D. CANAL
APPENDIX E 4
TYPE DESIGN OF ADJUSTABLE PROPORTIONAL MODULE
PLAN
CANAL
MAP LIBRARY
(SD) E.S. CRUMP,
EXECUTIVE ENGINEER
BALLOKI DIVISION L. B. D. CANAL
LUDHIANA
MORINDA
UMBALLA
PATIALA
KAITHAL
KARNAL

Taken at the British Library. Crump (1922) Paper and Sirhind Canal Map (1882) in view.

⑤

# Conclusion

# Conclusion

*We should begin to see all documentation as intervention, and all archiving as part of some sort of collective project. Rather than being the tomb of the trace, the archive is more frequently the product of the anticipation of collective memory*
→ Appadurai 2003, 16

The designs of a group of "unknown engineers" subtend the modern Indus Valley's hydrological systems, while their rationalities and desiderata lay stratified across disconnected archives. The APM represents a cast iron inflection point in the history of canal infrastructure, its operations and their consequences being archived within and through the alluvial substrata.

Sedimentary Desiderata has offered a counter mapping of the landscape that the APM produces. It has shown how the archival continues to exert force, produces and is itself a site of environmental struggle, while also representing opportunity as a site of intervention.

The project has worked through this problematic by staying-with the engineering desire and the contrasting geologic reality. In doing so, Lacey's unknown engineers and their works can be traced to the present.

This project has also highlighted that there is no monolithic 'archive' just as there is no monolithic 'rationality' to which colonial infrastructure and statecraft accorded to. Instead, it has been through the fusion of disparate stores of knowledge that Sedimentary Desiderata has charted the design geneology of the outlet and its impact.

However, if this project has reflected on the way knowledge and its representation was instrumentalised in the construction of canal colonies, can this framework be used to redress the harm caused? Sedimentary Desiderata has shown how the archive can speak to the production of environmental harm in the present. As the UNEP loss and damage fund continues to be developed and articulated, A granular analysis of the effects that colonial infrastructure has produced can serve to give specificity the damage produced while also pointing to the areas that need adaptation.

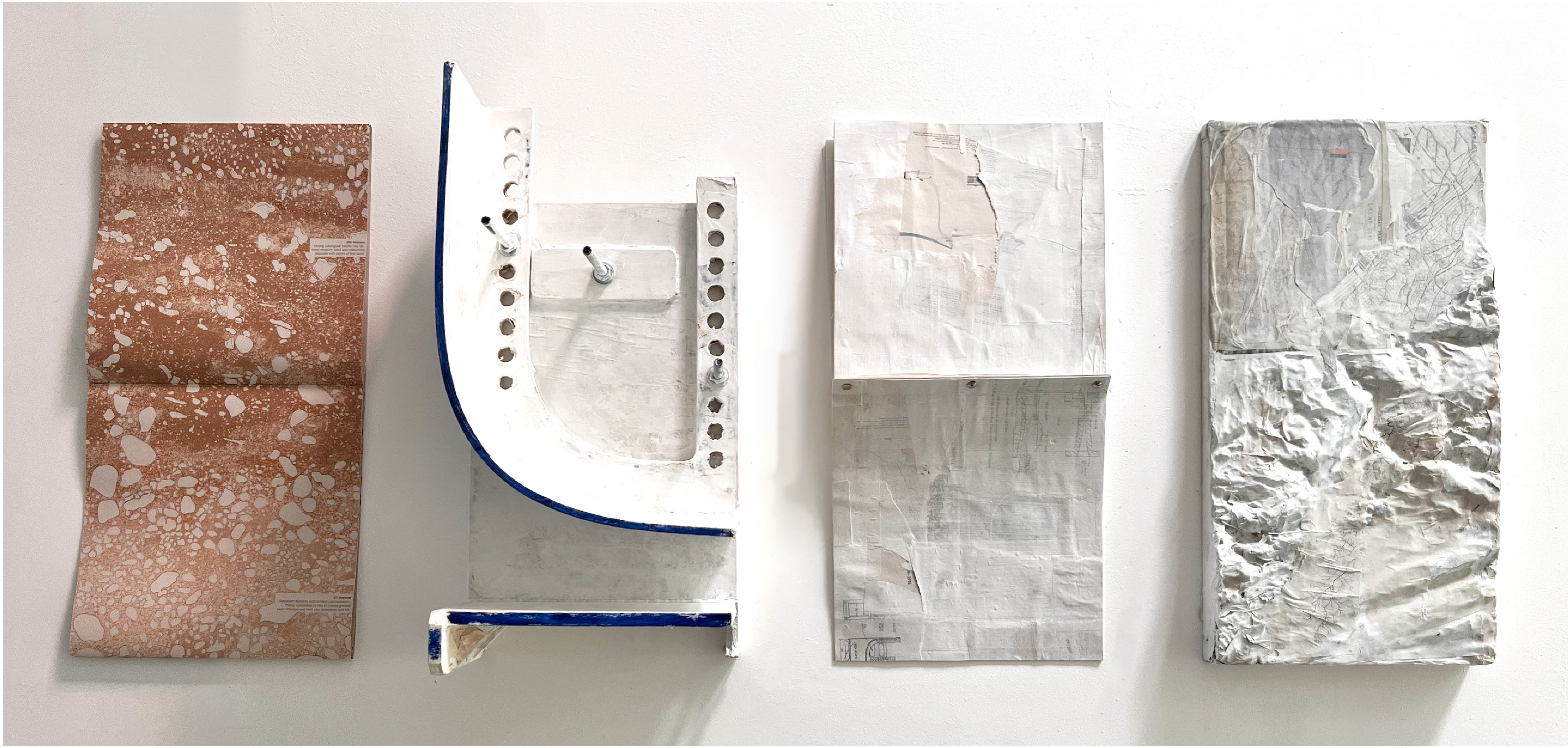
At the time of the COP27 summit, those opposed to the framework erroneously fought over the "benefits" of colonial infrastructure. Without problematising the desiderata of this infrastructure, and historicising the rationalities on which they were produced, then such misguided opposition will continue. The distinct dynamics of this design genealogy must continue to be de-sedimented to show that the standardisation of engineering infrastructure, and the rationalities it is subtended by, has gone on to excacerbate the consequences of extreme weather being faced today.

Although in entirely different circumstances, the Mau Mau legal case is a clear example of how the archive can speak to the damage caused historically and its ongoing consequences[Wessely, 2017]. As the Loss and Damage fund, or it's descendent schemes, are mobilised to adapt vulnerable landscapes, critical frameworks such as those outlined in this project offer new means to de-sediment existing narratives around technological progress and move towards design praxis that links of the textual and the geological substrate.

To prevent any future interventions from joining the genealogy of outlet designs that precede it, an Environmental Architecture should emerge from an aesthetical and knowledge practice that does not divorce the "territory" or the design at hand from the vertical, but understand 'architecture' to include both the geologic and the textual record.

Sedimentary Desiderata, alongside the project's discrete interventions, has at time of submission been entered into the legal deposit scheme. All material from this project has been uploaded to Archive.Org under the creator name of "Sedimentary Desiderata".

This Thesis is catalogued under the International Business Standard Number (ISBN) system as 978-1-3999-6209-4



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